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STORAGE

NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

JUNE, 1892.

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NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

No. 4. Vol. I. JUNE, 1892.

NOTES AND COMMENTS.

The Organisation of Science.

PROBABLY the two features in our social organisation of which the average Englishman is proudest are the historical continuity in the development of our institutions and the minute division of labour which condemns thousands of our countrywomen to spend their lives tying knots in broken threads. Every now and then, however, some iconoclast makes the startling discovery that the two are inconsistent, and that a rigid acceptance of the commercial system would enable our social and scientific institutions to carry on their work with less unnecessary waste and fewer unsatisfied wants. A very weighty protest against the existing confusion has just been issued under the above title, by a writer who, we regret to say, hides himself behind the *nom de plume* of "a Free Lance."[1] This essay is suggestive and interesting, and is obviously written by a man who knows a good deal about the inner working of our scientific societies, and feels deeply the necessity for radical, or, rather, revolutionary reform. He maintains that the conditions of affairs have so much altered since the principal scientific societies were founded that at present their main use is as co-operative publishing companies; their libraries, and the opportunities they afford of social union, are (or ought to be) valuable secondary aids. Since he regards publishing as their main function, he has, of course, little difficulty in showing that the work is done extravagantly and badly: numerous societies and journals cover the same ground, and, hence, a person studying a particular subject is compelled to use many journals, whereas our

[1] The Organisation of Science. By a Free Lance. London: Williams and Norgate, May, 1892. Price 1s. net.

author maintains that one in each country ought to be sufficient. Thus, he says the Royal Society publishes biological papers which ought to go to the Linnean Society, with the result that the contribution is issued with a series on wholly different subjects ; the younger biologists do not obtain the paper unless they can afford the heavy expense of buying the *Phil. Trans.*, while it is freely distributed to the Fellows of the other society, the majority of whom have no interest in the subject, and are unable to appreciate its importance. "This," says the Free Lance, "is worse than casting the children's bread to the dogs, for at least the dogs could digest it and benefit by it ; we simply cast their bread away." The essayist maintains that we have the same confusion all round : several societies or journals are doing the work that one ought to do, and the resulting pecuniary waste and administrative inefficiency has grown to such an extent "that the chaotic rule of the Heptarchy was almost orderly compared with the state of things now existing in the domain of science."

To find the way out of this darkest scientific England the author proposes to proceed on the waste-not-want-not lines, and thus to rescue the younger scientists at present submerged beneath the deluge of innumerable journals. He would have the Royal Society cease the publication of memoirs that come within the scope of the specialist societies, and confine itself to the work of indexing and abstracting literature, attending to the business and educational work of science, and acting as Universal Bibliographer. Each other society should confine itself rigidly to its own sphere, and not encroach on that of its neighbour. The Zoological Society should give up its system "of flagrantly robbing the Linnean Society" by publishing zoological papers "of high scientific importance," and confine its attention to feeding the animals at the Zoological Gardens. The Microscopical Society should publish only on microscopes and microscopic appliances, while all the smaller provincial journals, and those not connected with any society, such as the *Quarterly Journal of Microscopical Science*, the *Annals of Botany*, &c., should promptly cease to exist. Against the unfortunate botanists who founded the last-mentioned journal the "Free Lance" runs his most furious tilt; he regards this as the mere "wanton extravagance of publication," and as "the most wanton and inexcusable instance of journalistic disorganisation that could be found." The local societies and their journals he proposes should be all affiliated to the London societies in a general federation, compared with which we fear the feat of the great Cape Amalgamator was but child's play. The idea, however, is a good one.

In all this there is, it must be admitted, a distinct measure of truth ; and the author states the points with such vigour and incisiveness that he may be excused for exaggerating the evils of the case. Everyone who has seen much of the working of the English scientific societies has felt the same difficulties, while recognising also that as

they are the outcome of a century of progress they cannot be obviated in a day. The essayist's plan of one Science one Journal would also mean one Science one Editor, and the reign of a powerful but small centralised bureaucracy. The system of having papers examined by specialists before publication seems to be essential and to work well upon the whole, so long as there are several competing journals; but if there were only one, there might simply be a monopoly of publication in the hands of a small clique. No doubt the occasional publication of a biological memoir in the *Philosophical Transactions* is inconvenient to one who only takes in the *Journal of the Linnean Society*; but then so is the publication of a long telegram in the *Times* to one who trusts to a brief summary in the *Star*. That, however, is not so much an argument for the fusion of all the daily papers, as for improving our system of indexing periodical literature. If the Royal Society would do more of this in the future than it has done in the past, it would no doubt be well; but it seems to us it would be a misfortune to remove the stimulus of the issue of a journal in which, like the Belgian *Mémoires Couronnés*, a Naturalist may hope to publish his finest piece of work. In other departments there seems to be a tendency towards a better distribution of papers; palæontological papers that bear simply on systematic Zoology as apart from the problems of Geology are being contributed more to the Zoological, than to the Geological Society; while as the same society is receiving more of the Zoological work, the Linnean Society will in time probably find its true place as the Botanical Society of London.

By slow changes such as these more good is likely to be wrought than by any of the revolutionary methods advocated by our essayist. His proposal to abolish competition would retard progress and endanger liberty, and, like the late Archbishop McGee, we would rather have British science unorganised and free than economical and enslaved. The author, however, does not seem to regard his own proposals as likely to be accepted, and he might well have adopted as his motto Carlyle's lament that "Labour will vainly need to be somewhat 'organised' as they say—God knows with what difficulty."

The Life-History of the Lobsters.

During the past few weeks an unusual number of important contributions have been made to the discussion of some of the most fundamental problems of modern Biology. Fanciful speculations and "genealogical trees," of course, flourish as ever; but there is an obvious tendency in nearly all directions towards a more minute and laborious study of the facts and phenomena in which the processes of life must be ultimately revealed. Investigations like those of Brooks and Herrick on the life-history of the Macrurous Crustacea, of Jousseaume on the distribution of the varieties of Mollusca in the Red Sea, and of Kükenthal on the development of the mammalian

teeth, are substantial advances of which the importance cannot be over-estimated.

The researches of Professor W. K. Brooks and Mr. F. H. Herrick, of which a general preliminary account appears in the April *Johns Hopkins University Circular*, seem to have an especially important bearing on certain current doctrines in Evolution. If these authors' interpretation of the facts in the observed life-history of several highly organised Crustacea be correct, it would appear that a single specific type of animal may result from the development of two or more different series of immature stages—that either the life-history of the individual does not always recapitulate the history of the race, or else that any existing type of life may have been evolved from several distinct but gradually converging series of ancestors. We cannot do better, indeed, than quote from the Report to show the nature of the evidence:—

"One of the most remarkable results of our study of the various species of the genus *Alpheus* is the discovery that, while there is such a general similarity as we might expect between the larval stages of the different species, the individuals of a single species sometimes differ more from each other, as regards their metamorphosis, than the individuals of two very distinct species.

"This phenomenon has been observed by us and carefully studied in two species, *Alpheus heterochelis* and *Alpheus saulcyi*. . . . In the case of the first species, the difference seems to be geographical, for while all the individuals which live in the same locality pass through the same series of larval stages, the life-history of those which are found at Key West is very different from that of those which live on the coast of North Carolina, while those which we studied in the Bahama Islands present still another life-history. In the case of the second species, *A. saulcyi*, the difference stands in direct relation to the conditions of life. The individuals of this species inhabit the tubes and chambers of two species of sponges, which are often found growing side by side upon the bottom, and the metamorphosis of those which live in one of these sponges is quite different from that of those which inhabit the other. In this species the adults also are different from each other, but as we found a perfect series of transitional forms there is no good reason for regarding them as specifically distinct, and in the case of the other species, *A. heterochelis*, we were unable, after the most thorough and minute comparison, to find any difference whatever between adults from North Carolina and those from the Bahama Islands, although their life-histories exhibit a most surprising lack of agreement. In fact, the early stages in the life of *A. heterochelis* on the Bahama Islands differ much less from those of *A. minor* or *A. normani*, than they do from those of the North Carolina *A. heterochelis*, and, according to Packard, the Key West *heterochelis* presents still another life-history.

"The phenomenon is, however, a highly remarkable one, and worthy the most thorough examination, for it is a most surprising departure from one of the established laws of embryology; the law that the embryonic and larval stages of animals best exhibit their fundamental affinities and general resemblances while their specific characteristics and individual peculiarities make their appearance later."

We may add that partly analogous results have lately been obtained by Mr. G. A. Boulenger in the study of the tadpoles of frogs and toads (*Proc. Zool. Soc.*, 1891, pp. 593–627). The tadpoles of one and the same species found in different ponds often vary much in size and coloration, and in some other characters, whereas the adults evolved from these tadpoles exhibit no corresponding differences. The subject thus opened up is one of very wide import, and the appearance of Messrs. Brooks and Herrick's completed work in the *Memoirs of the National Academy of Sciences* will be anxiously awaited, both by zoologists and palæontologists.

The Mollusca of the Red Sea.

From its geographical position, the Red Sea exhibits features of perennial interest to biologists, and the new account of its molluscan fauna appearing in the last number of the *Annales des Sciences Naturelles* (vol. xii., pp. 343–363, 1892) is a welcome contribution to the literature of the subject. Dr. Jousseaume, the author of this memoir, has made extensive explorations in the Red Sea, with the result that he is able to add 200 species to the list of 800 species of mollusca already recorded by previous observers. He has also discovered a new species of *Cistella* which is the first Brachiopod obtained from the Red Sea. Dr. Jousseaume supports the belief that the molluscan fauna of this area presents no close affinities with that of the Mediterranean; and he believes that the species stated by some previous observers to be common to these two basins have been recorded by mistake. He especially instances the use of Mediterranean sponges at Suez, and shows how some of the shells supposed to occur here have been brought with these articles of commerce. The Red Sea is, indeed, as Mr. Edgar Smith pointed out last year (*Proc. Zool. Soc.*, June 16, 1891), to be regarded as a large gulf of the Indian Ocean.

The great value of Dr. Jousseaume's work, however, lies in the attention he has given to the variation of some of the commoner species of the mollusca in accordance with their surroundings. He finds that certain forms are absolutely stable, whatever be the nature of their environment; variations being confined exclusively to differences in the intensity of the coloration. On the other hand, there are many species that appear to exhibit almost as many varieties as can be observed in any species of domestic animals. These "modify their forms, vary their colour, multiply or simplify their ornaments" according to circumstances. At the same time, Dr. Jousseaume is a firm believer in the reality of "species," and his observations on this point are worthy of special quotation :—

"However great may be the variations I have observed in the different individuals, they have always appeared to me to be confined within certain limits for each species—limits which could not be

transgressed either by the influence of the surroundings or by slow and progressive evolution. These limits are so sharply defined that, notwithstanding the great number of species of mollusca founded upon insufficient materials, it has always been easy for me to distinguish one species from another. I would even add that among the twelve or fifteen thousand species I have studied, I have never found intermediate species establishing a gradation from one to another, and I have only recognised in the variability of mollusca a peculiar faculty by which certain species are enabled to assume the form and coloration of the bodies on which they are fixed—a provision through which they can live without danger in localities of different aspect and greater extent.

"Moreover, I cannot explain to my satisfaction the passage of one species to another, without assuming an abnormal cause, which, suddenly coming into operation at undetermined periods in certain parts of the globe, would change the direction of growth which each species inherits from its birth."

Palæontologists, we imagine, will dissent from the latter proposition most emphatically; and we may express the hope that Dr. Jousseaume will soon be able to publish some precise details as to the evidence on which his conclusions are based. So far as the shape and ornamentation of the shells are concerned, numerous examples of the most gradual modification of the forms of one geological stratum into those of an immediately overlying stratum, could be cited by almost any student of the Secondary and Tertiary mollusca.

The Succession of Teeth in the Mammalia.

It is a familiar fact that, whereas nearly all the lower vertebrates —fishes, batrachians, and reptiles—have an almost unlimited power of reproducing their teeth as occasion requires, the higher vertebrates, or mammals, are never provided with more than one change of teeth during their lifetime. It has also been for a long time well ascertained, that the lower mammals (Marsupialia) as a rule exhibit even less change of teeth than the higher (or placental) mammals. There has thus been great difficulty hitherto in explaining the manner in which the mammalian type of dentition became evolved from the primitive constantly-reproduced type such as we observe, for instance, in the crocodiles. Numerous theories have been proposed to account for the apparent anomaly that the lower mammals exhibit less tooth-change than the higher mammals; while, contrary to the teaching of the great pioneers in Comparative Anatomy such as Cuvier and Owen, the majority of the modern School has long held the belief that mammals originally possessed but one set of teeth and gradually acquired the power of reproducing part of this set once in a lifetime.

The remarkable investigations of Dr. Willy Kükenthal, treated in a lecture published last month,[1] and in previous, more detailed

[1] "Ueber den Ursprung und die Entwickelung der Säugetierzähne," *Jena. Zeitschr. f. Naturw.*, vol. xxvi, pp. 469–489 (1892).

communications to the *Anatomischer Anzeiger* for 1891, have now afforded a definite solution of the problem. It appears from an examination of some embryos of opossums that the replacing set of teeth is actually present in the jaw, although only one of these teeth ever completely develops and becomes functional. It is also proved rom a study of the embryos of certain armadillos and toothed whales in which no tooth-replacement has been observed, that the replacing set is actually formed though absorbed without use in the adult. In short, we may definitely conclude that mammals originally inherited two sets of teeth from their cold-blooded ancestry—that in some groups such as the toothed whales, some armadillos, and marsupials, the second set of teeth is almost or quite aborted, while in the majority of the higher mammals this set is functional and partly replaces the first set. As a matter of fact, the two series of teeth in the jaw of the embryo always originate by the division of a single series of germs; and in this respect the mammalian dentition presents some difference from that of the reptiles and batrachians. There are, moreover, other points still awaiting elucidation, as remarked in a critical article by Mr. Oldfield Thomas in the April number of the *Annals and Magazine of Natural History*.

Palæontology, as usual, may be expected sooner or later to assist in the solution of the remaining difficulties; and it is interesting to notice in the May number of the *American Journal of Science* (vol. xliii., p. 446) that Professor Marsh has already a small contribution to the subject. In describing the primitive Eocene mammals, *Hyracops* and *Meniscotherium*, the Professor remarks that the replaceable first set of teeth remains in use long after the appearance of the three permanent molars, thus suggesting that the latter are actually a retarded portion of this first set, and not part of the second series.

The Australian Marsupial Mole.

Last month we briefly quoted Professor Cope's observations on the affinities of the much-discussed *Notoryctes*,[1] but refrained from comment in view of Dr. Hans Gadow's promised contribution to the Zoological Society. The results of Dr. Gadow's personal examination of the original specimens brought to England by Professor Stirling were presented to the meeting of this society on May 3, and we congratulate Professor Stirling on the manner in which his work in a distant colony has been confirmed by the subsequent researches in the Museum of Comparative Anatomy at Cambridge. Dr. Gadow recognises the functional pouch and the mammæ placed within; he finds the peculiar arrangement of the urinogenital organs of the male so well known in the Marsupials; and he notes certain skeletal characters that indicate affinities with the same order. In short, Dr. Gadow finally disposes of all doubts as to the non-placental character

[1] *Supra*, p. 167.

of *Notoryctes*, while he shows that both the external resemblances of the animal to the Golden Mole (*Chrysochloris*), and the similarity between the skeleton of its trunk and that of the armadillos, are the result merely of adaptation to a corresponding mode of life. We may even go further and remark, that not only is Professor Cope mistaken in the views he bases on Professor Stirling's writings (he does not appear to have seen actual specimens) but he is also unfortunate in the concluding generalisation on the fauna of Australia as compared with that of South Africa. According to Günther (Catal. Fishes, vol. vii., p. 373), *Gonorhynchus greyi* is not a freshwater, but a marine fish, and occurs both on the coasts of Australia, South Africa, and Japan. The comparison of the Chelonian faunas of South Africa and Australia is particularly unfortunate, from the fact that the South African Pleurodiran tortoises exhibit affinity with the South American, and not with the Australian forms; while the discovery of Insectivores in Australia would only be comparable to the discovery of an emydian Chelonian in that part of the world.

The Glacial Period in the South of England.

The difficult problem of the condition of the south of England during the Glacial Period is again discussed by Professor Prestwich and by Mr. Clement Reid in the May number of the *Quarterly Journal of the Geological Society* (vol. xlviii., pp. 263–361). Professor Prestwich concludes that the raised beaches on the coast of the English and Bristol Channels are contemporaneous with the newer river-drifts of the Thames and Somme valleys; that an uplift not exceeding 120 feet followed the formation of these beaches; and then occurred the period of the Coast Caves and their fauna, and of certain Raised Dunes or Blown Sands. He further argues in favour of a subsequent submergence of the land in one of the latest phases of the Glacial Period. Evidence of this submergence, perhaps to an extent of 1,000 feet, is recognised in the remarkable accumulations of angular gravel or "rubble-drift" that cannot be explained by the ordinary action of weathering. Re-elevation followed after a short interval, and during the emergence there was formed the main portion of this "rubble-drift," which includes the accumulations known as "head," the "Coombe Rock" of Sussex, &c. Some of the fissures filled with ossiferous drift were also formed during the period of elevation. The deposits that followed this final upheaval are those grouped as Recent, including the Alluvium of our rivers. Hence it is that Professor Prestwich concludes "that the Glacial times came, geologically speaking, to within a measurable distance of our own times, and that the transition was short and almost abrupt."

Mr. Reid, on the other hand, deals not only with some of these irregular accumulations, but also with the deposits representing earlier phases of the Glacial Period, founding his remarks on a

careful examination of the Sussex coast in the neighbourhood of Selsea. At the base of the local Pleistocene deposits Mr. Reid has discovered great boulders—some of greenstone and granite, some of comparatively local rocks—squeezed into the underlying Eocene clay; and one block of Bognor Rock is recorded as showing a well-marked striated surface, a feature probably produced by the agency of shore-ice. Immediately above the layer of boulders, sands and clays yield evidence of a temperate fauna and flora; and above these again is the "Coombe Rock" which evidently betokens a return of glacial conditions. Mr. Reid, therefore, concludes that there is distinct proof of an interglacial or mild episode; and he considers that the succession of deposits in the Thames valley may be interpreted in precisely the same manner. The newer rough flint-gravel and stony brickearth in the Thames valley are to be regarded, in his opinion, neither as marine nor as fluviatile, but as frozen soil gravels accumulated on plains gently sloping towards the river. Mr. Reid further expresses his belief that the excavation of the Thames valley dates back to the period of the Chalky Boulder Clay, at a time when the river flowed parallel with the southern margin of the ice-sheet and received its sub-glacial drainage as well as that of its own catchment-basin. The conclusions thus suggested are highly interesting, even if they be heterodox, and they are, at any rate, calculated to stimulate enquiry.

Recent Progress in the Study of Algæ.

So much activity has been displayed during recent years in Phycology, that the anticipation may be safely entertained of a speedy journey over the remainder of the path to be traversed to the point where it shall be abreast of the study of Fungi. Much of this progress has been made abroad, and among recent writings, such papers as those of M. Bornet on *Ectocarpus* (*Bull. Soc. Bot. France*), Graf zu Solms Laubach on *Cymopolia*, *Neomeris*, and *Bornetella* (*Ann. Jard. Bot. Buitenzorg*), deserve mention as solid contributions to our knowledge. The excellent *Atlas deutscher Meeresalgen* of Professor Reinke has somewhat prematurely reached its conclusion. It now consists of 50 illustrations instead of the 100 we were led to expect, and it is greatly to be regretted that the encouragement offered did not warrant a continued existence. As it is, our knowledge of the Phaeophyceæ is greatly the better of the volume. The *Sylloge Algarum* of Dr. De Toni, proceeds without pause, though at present it is travelling over the waste fields of Diatomaceæ. This great systematic undertaking is distinguished more for its merits as a storehouse of reference than as a critical treatment of the Algæ. It is, in fact, anything but critical. Wille has completed his account of the Chlorophyceæ in Engler and Prantl's *Nat. Pflanzenfamilien*. This account is intended as a critical review of facts, but in this

respect it rises little above De Toni. In fact, it is studded with minor blunders and others of moment. For example, the figuring of *Chlorodictyon* as an alga near *Caulerpa* (while it is a lichen with abundant and well-marked apothecia) is scarcely excusable. Agardh had so published it, but Asa Gray promptly put the matter right in the *American Journal of Science*, and more recently Cramer confirmed the emendation.

In this country, which, in the days of Greville and Harvey, held the lead in the study of Algæ, it is very gratifying to report investigation of a thorough kind. Recent papers by Messrs. Murray, Boodle, Massee, Traill, Batters, Harvey Gibson, John B. Carruthers, and of a talented lady worker at this subject, Miss Barton, have appeared in the *Journal* and the *Transactions of the Linnean Society*, the *Journal of Botany*, the *Annals of Botany*, and the *Transactions of the Botanical Society of Edinburgh*. The most noteworthy recent publication is the *Phycological Memoirs* (Dulau & Co.) to which we briefly referred last month. These memoirs embody researches in Algæ conducted in the Department of Botany in the British Museum, where an active band of workers have leagued themselves together. The *Memoirs* are edited by Mr. George Murray, and if this first part is a specimen of future numbers we may be well satisfied as to its success. The first paper introduces a new type of alga into botanical literature. Miss Mitchell and Miss Whitting (both hailing from Newnham) have studied minutely and with judgment *Splachnidium rugosum*, an alga from the Cape, which they elevate into the type of a new order, Splachnidiaceæ, intermediate between Fucaceæ and Laminariaceæ. It bears sporangia like *Laminaria*, in conceptacles like those of the Fucaceæ, but developing after a different fashion, as becomes a new order. It may seem a courageous act on the part of two young botanists to found a new order in what we take to be their first essay in Phycology, but the step is abundantly justified, and they have earned the congratulations of sterner and more experienced workers.

The next two papers are by Mr. Murray. The first, on a fossil alga from the Oolite—a *Caulerpa* from the Kimmeridge Clay—contains also a brief and critical *resumé* of our knowledge of fossil Algæ, in which he takes the side of Nathorst against Saporta. This record appears, on his showing, to be the first evidence of a genuine alga from the secondary rocks. The other paper by Mr. Murray deals with an obscure alga, *Dictyosphaeria*, belonging to the Siphonocladaceæ, in continuation of previous work at this group. Miss Barton is author of a paper on malformations of *Ascophyllum* and *Desmarestia*, also in continuation of previous work on the pathology of Algæ, a subject of which very little is known. The malformation of *Ascophyllum* is due to the operations of a new marine Nematode worm.

Mr. Batters concludes the number with the description of a new genus of perforating Algæ found in the Clyde. His figures, like the other plates of this well-printed publication, are excellently rendered,

but we may well be excused if we fail to accept the statement that the bodies figured as spores are such—on the evidence of the figures. A phycologist of his experience is not likely to have been deceived on a point of this kind, but, as the matter stands, there is little to be said and more to be doubted. However, the authors of these *Memoirs* have certainly to be congratulated on the success of their first number from a scientific point of view. The publication deserves encouragement from botanists, and no doubt will meet with it by making itself indispensable to workers.

The geographical distribution of animal life in North America forms the subject of an interesting memoir by Dr. C. Hart Merriam in the last part of the *Proceedings of the Biological Society of Washington* (vol. vii., pp. 1–64), issued on April 13. With the aid of a coloured map, Dr. Merriam points out that a series of six irregular zones of life may be distinguished in succession on proceeding from the border of the Arctic region southwards. As the result of the investigation, he considers that Mr. Wallace underrates the importance of temperature in determining the distribution of life. He also remarks that the last-named authority is mistaken in supposing that on the two sides of the Rocky Mountains "almost all the mammals, birds, and insects are of distinct species." Dr. Merriam, indeed, entirely disagrees with Mr. Wallace in his views on the distribution of life in North America; and in the concluding section of the memoir he briefly touches on the wider question of the life-provinces of the Northern hemisphere as follows:—

"It now becomes evident that the so-called Palæarctic and Nearctic Regions are the result, in each case, of confounding and combining two wholly distinct regions—the Boreal with the Sonoran in America, and the Boreal with the analogue of the Sonoran in Eurasia. Eliminating these austral elements as wholly foreign to the region to which they have been so persistently attached, there remains a single great circumpolar Boreal region characterised by a remarkably homogeneous fauna, covering the northern parts of America and Eurasia."

For a mass of interesting details we must refer our readers to the memoir itself.

Dr. Georg Baur publishes a preliminary account of his recent visit to the Galapagos Islands in the current number of the *Biologisches Centralblatt* (vol. xii., Nos. 7, 8, April 30, 1892, pp. 221–250). Contrary to the usual belief, Dr. Baur concludes from his observations that these islands were directly connected with the mainland of the American Continent in the early part of the Tertiary period. He also remarks that some portions of the islands display a much more luxuriant vegetation than was observed by Darwin in the comparatively arid localities visited by the "Beagle." The promised detailed report will be awaited with interest.

Dr. D. G. Brinton, Professor of American Archæology in the University of Pennsylvania, has just issued a stirring appeal to the American seats of advanced learning, entitled "Anthropology as a Science, and as a Branch of University Education," pleading for the establishment of a branch of Anthropology in American Universities. It gives an account of the *status* of this question, so far as Europe is concerned, and is accompanied by a comprehensive and well-considered scheme for instruction in Anthropology in its various divisions of Somatology, Ethnology, Ethnography, and Archæology, including laboratory work, both physical and technological, and work in the library and in the field. Dr. Brinton has also published some interesting papers on South American Linguistics, "Native Languages from MSS. and rare printed sources," originally contributed to the *Proceedings of the American Philosophical Society* in the early months of the present year. The languages of the native tribes of South America are probably the least known of any on the globe.

In the last number of the *Zeitschrift für wissenschaftliche Zoologie* (vol. liii., suppl., pp. 43–66, pls. vi., vii., 1892) Professor R. Wiedersheim continues his important researches on the pelvic arch in vertebrates, by discussing its most anterior element or *epipubis*. In *Polypterus* and the Dipnoan fishes, the Professor points out this is merely a process of cartilage strengthening the ventral body-wall, and assisting in the fixation of the pelvis. In other cases—as in salamanders, *Amphiuma*, and reptiles—it serves as the origin of some of the muscles of the hind-limbs. Finally, as a pair of "marsupial bones" in the pouched animals the epipubis again appears to be of chief functional importance as a support of the body-wall. There is a rudiment of the cartilage that gives rise to the marsupial bones in the embryos of all mammals; but in almost all placental mammals it has degenerated in the adult.

The gradual evolution of the complex grinding teeth of the modern hoofed mammals has already been satisfactorily traced by the study of their extinct ancestry. Hitherto, however, with the exception of Klever's researches on the horse, we have had little detailed information as to the gradual development of the teeth in the immature stages of the various existing species. A small, beautifully illustrated memoir by Dr. Julius Taeker, "Zur Kenntniss der Odontogenese bei Ungulaten," just published as an Inaugural Dissertation at Dorpat, will thus be welcomed by specialists interested in the subject. A "bunodont" stage is always passed through however "selenodont" and "hypsodont" the dental crowns may ultimately become; and Dr. Taeker has been able to examine embryos of the horse, pig chevrotain, elk, roe-deer, sheep, and ox.

Entomologists, as a rule, are apt to despise fossil insects, from their ordinarily very fragmentary state of preservation; but we would commend to their special notice the latest discovery in the English Lias described by Dr. Henry Woodward in the May number of the *Geological Magazine*. This is an exquisite example of a Termite (*Palæotermes ellisii*) discovered by Mr. Montagu Browne at Barrow-on-Soar, Leicestershire, exhibiting even the patches of pigment on the wings.

It has long been a matter of astonishment that so few traces of the siliceous skeletons of Radiolaria should be found in the geological formations below those of the Tertiary period. At last, however, the explanation of the mystery is forthcoming, and in the newly-issued part of the *Palæontographica* (vol. xxxviii., pp. 107–200, pls. vi.–xxx., 1892), Dr. Rüst shows how these fossils can be met with almost anywhere, even in the Palæozoic rocks, provided the correct siliceous matrix (usually of only local occurrence) be examined. After a detailed study of thousands of thin sections of hornstones, jaspers, siliceous slates, &c., Dr. Rüst arrives at the conclusion that almost all the Palæozoic Radiolaria can be referred to the genera recognised by Haeckel in the seas of to-day. They afford no insight whatever into the evolution of the group; and the only noteworthy distinctive feature of the Palæozoic Radiolarian fauna appears to consist in the relative abundance of the complex Sphæridiidæ and the comparative absence of Cyrtidiidæ. We may add that Dr. Rüst has overlooked the discovery of Radiolaria in the Lower Silurian (Ordovician) of Scotland, investigated two years ago by Dr. G. J. Hinde.

The remarkable irregular loose surface-deposit known as *loess*, met with in so many parts of Central Asia, is again attracting attention. In the *Comptes Rendus* for April 19, 1892, M. Guillaume Capus records some observations on this formation, especially in Turkestan, and thinks that the greater part of the deposit must have been formed in water. The stratification, the variations in composition, and the occasional intercalation of conglomerates seem to indicate this mode of origin; while it is probable that many local accumulations of comparatively small extent are due to the re-arrangement and re-distribution of the materials by the wind.

The divining rod continues to be employed in this country for the purposes of finding water. In the *Daily Graphic* for April 23 there is a picture of "A Water Wizard in the Isle of Wight"; while on April 19, at Wells, in Somerset, a paper on the Divining Rod was read by Mr. Hippisley before a joint meeting of the local branch of the University Extension and the Wells Natural History Society, the

chair being taken by the Lord Bishop. Mr. Hippisley thought that the subject of "Dowsing" (or the use of the divining rod) might not improperly be classed among those connected with natural history. He mentioned some of his own successful experiences in finding water by means of the rod, and, in explanation, referred to the fact that running water is a good conductor of electricity; his theory being that persons having the "gift" are more susceptible to electric or magnetic action, and that the manner of holding the rod forms a circuit, whereby the operator is affected when passing over a subterranean water-course. We may add that an interesting historical account of the subject, by Mr. R. W. Raymond, was published by the United States Geological Survey ("Mineral Resources of the United States," 1883, pp. 610–626). In this article Mr. Raymond remarked that the application of the rod dated from a very early period, and that it had been used to divine character, and for various other purposes, as well as in the search after mineral treasures and water.

Some unknown fossil seeds from the Cromer Forest-bed, received from Mr. Clement Reid, have just been identified by Professor A. G. Nathorst as belonging to *Naias marina*, a plant now only living at one locality in Britain, in Hickling Broad, Norfolk. Dr. Gunnar Andersson, who first recognised the species in a fossil state, points out that, like *Trapa natans*, it was formerly more plentiful, for he has found the sub-fossil seeds in peat-mosses in various parts of southern Sweden, and has also identified specimens in collections from Schleswig-Holstein, Germany, and Switzerland.

Captain Bower and Dr. Thorold arrived last month at Simla, having completed their journey from India to China across the Tibet tableland, a distance of over 2,000 miles, all of which, except a few miles, has not before been explored. Journeying east, from the Lanakma Pass, they met with a chain of salt lakes, one of which, Hor-Ba-Too, proved to be 17,930 ft. above the sea. The travellers passed within a few marches of Lhassa, but, as is usual, they were required to make a detour to the north. Captain Bower is now engaged in writing his report and completing his maps. Another expedition to the same district (the Tibet tableland) and to the Chinese province of Szechuen, is being promoted by the Russian Government, who have voted 30,000 roubles for the purpose.

I.

The Antelopes of Somali-Land.

AFRICA is truly the land of Antelopes. Of about one hundred and twenty of these graceful Ruminants known to Science, nearly four-fifths are found only within the limits of that continent, and, with few exceptions, all the largest and most highly-developed forms of these animals are restricted to the Æthiopian Region. Antelopes are found over every part of Africa, from Algeria to the Cape, and from the Gambia to Zanzibar. They are met with in every variety of country, whether it be desert, swamp, grassy plain, or forest. Each kind of country has its peculiar forms of Antelope, whereas the Deer, which frequent corresponding situations in all other parts of the world except Australia, are entirely absent from the Æthiopian Region.

Although, as has just been stated, Antelopes are to be met with in every part of Africa, they are most numerous where the country is comparatively open, and where there are grassy plains interspersed with sheltering bushes. South of the Tropic of Capricorn this condition generally prevails, and throughout the Cape Colony and its adjoining territories Antelopes are—or, at all events, before the advent of a European population were—everywhere abundant. The early settlers at the Cape describe Antelopes as to be met with in herds of thousands on the "veldt," and in parts of Africa where the white man and his destructive firearms have not yet penetrated a similar condition prevails even at the present day. When we advance farther north and meet with the dense forests of the Congo and Niger basins we find the mass of Antelopes holding rather to the more open lands on the eastern coast, throughout which they are to be met with in great abundance up to Cape Guardafui. The vast plains traversed by the Upper Nile and its tributaries are likewise well-stocked with Antelope life; but, in the Great Sahara, only some of the more desert-loving forms are to be found. In Senegambia, again, and in the more open districts on the West Coast, many forms of Antelopes occur, but they cannot rival the numbers and varieties of those of Eastern and Southern Africa.

In former days, the sportsman or naturalist who was interested in the pursuit of Antelopes would undoubtedly have taken his passage to Cape Town, and proceeded thence into the interior. At the present time, however, as we have already mentioned, Cape-land is well-nigh

bereft of Antelopes, except some of the smaller and more ordinary species. It is consequently to the East Coast that the pursuer of large game would in these days rather betake himself.

On the East Coast of Africa, nearly under the Equator, at the base of snowy Kilima-njaro, there is a well-known "paradise for sportsmen," the praises of which have been sung by Sir John Willoughby.[1] Here Giraffes, Elephants, Rhinoceroses, Hippopotamuses, and some 16 kinds of Antelopes, amongst which are the Eland, the Koodoo, the Waterbuck, and others of the largest and finest sorts, may still be met with in a state of nature, though it is doubtful how long they will withstand the advance of the "sporting Saxon." But it is not to Taveta and the dominions of the Imperial British East African Company that I now wish to invite special attention. Further north, on the East Coast, and even of easier access to the European Naturalist, what Mr. James calls the "Unknown Horn of Africa" projects into the Indian Ocean. Here, as our sporting friends have lately shown us, a still more remarkable assemblage of Antelopes prevails than is found even round Taveta. Of the 12 Antelopes to be met with within reach of the port of Berbera, four belong to recently discovered species, and two of these are so different in essential characters from their nearest allies that it has been found necessary to institute new genera for their reception. It is on these remarkable forms that we wish to say a few words on the present occasion.

Amongst the newly-discovered Antelopes of Somali-land the most remarkable is certainly the "Gerenouk," or Waller's Gazelle (*Lithocranius walleri*). This singular form was first described by the late Sir Victor Brooke, in 1878,[2] from some skulls belonging to Mr. Gerald Waller, and obtained by that gentleman on the coast of Eastern Africa. Sir Victor described and figured this very peculiar cranium, which differs from that of all other Gazelles in the great backward prolongation of the occiput. Sir Victor likewise pointed out that the skull is much more depressed, that the facial axis forms a more obtuse angle with the cranial axis, and that the rami of the lower jaw are more slender in this than in any other Gazelle. While, however, he did not remove the species from the genus *Gazella*, he expressed much doubt as to "whether it should not constitute the type of a new sub-genus."

In 1884, I first obtained two flat skins of Waller's Gazelle among a series of specimens from Somali-land, sent to me by Mr. C. Hagenbeck, of Hamburg. At the same time, Mr. F. L. James was kind enough to favour me with the loan of a mounted head of the same Antelope from a specimen which he had shot in Northern Somali-land. It was not without much difficulty that I was enabled

[1] "East Africa and its Big Game." London: Longmans, 1889.

[2] *Proc. Zool. Soc.*, 1878, p. 929.

to associate the head and the flat skins with the skull previously described by Brooke, and thus, for the first time, to give some account of the external form of this Antelope. The skins, as I pointed out,[3] are at once recognisable by the very wide and well-marked dark brown dorsal line, which measures seven or eight inches across the back in its widest part, and stands out in strong contrast to the lighter rufous of the sides. Waller's Gazelle, however, is still more noticeable externally on account of its long thin neck, which, as

Fig. 1.—Waller's Gazelle, *Lithocranius walleri* (*Proc. Zool. Soc.*, 1892, p. 101).

Mr. Lort Phillips has stated,[4] has considerable resemblance to that of a Giraffe. This peculiar feature is well shown in the mounted specimens of this Antelope lately placed in the Gallery of the British Museum, from one of which the accompanying drawing (Fig. 1) has been taken.

In 1886, Herr Kohl, in an article upon "new or rare Antelopes in the Natural History Museum of Vienna," proposed to elevate

[3] *Proc. Zool. Soc.*, 1884, pl. xlix., fig. 1. [4] *Proc. Zool. Soc.*, 1885, p. 931.

Waller's Gazelle to generic rank under the title *Lithocranius*,[5] a course which was fully justified, and has been since adopted by Mr. Thomas and myself.

Waller's Gazelle, I should add, appears to extend throughout Somali-land down to the Tana River, where Sir John Willoughby and his companions found it "numerous."[6] It also occurs, though rarely, in the Kilima-njaro district.

In Northern Somali-land, Captain Swayne tells us the Gerenouk is one of the commonest and most widely distributed Antelopes, and is readily distinguishable by its long neck, large giraffe-like eyes, and long mobile muzzle. It is more of a browser of bushes than a grass-feeder, and may be sometimes seen standing on its hind legs with its neck extended, and its fore feet lodged against the trunk of a tree in order to get at the tender shoots and young branches.

The Gerenouk is found all over Northern Somali-land in small families, never in large herds. It is generally met with among scattered bushes, in ravines, and on rocky ground. Its trot is awkward, looking like that of a camel. This Antelope seldom gallops, and its pace is never very fast.

Nearly allied to the Gerenouk, and in some respects intermediate between that form and the typical Gazelles, comes the second newly-discovered Antelope-type of Somali-land—the "Dibatag" or Clarke's Gazelle (*Ammodorcas clarkei*). The first noticeable peculiarity of this form is that, unlike all its relatives of the gazelline subdivision, it has its horns curved and projected straight forwards, like those of the Reed-bucks (*Cervicapra*). So striking is this conformation, that when Mr. Oldfield Thomas received the first pair of horns of this species from his correspondent, Mr. T. W. H. Clarke, he called it *Cervicapra clarkei*.[7] About the same time, however, Captain Swayne kindly forwarded to me two pairs of horns with face-skins attached to them. The examination of these at once showed that *Ammodorcas*, as Mr. Thomas subsequently proposed to call it, had nothing to do with the Reed-bucks, and was most nearly allied to the Gazelles. *Ammodorcas*, in fact, as Mr. Thomas[8] has stated, combines the horns of a Reed-buck with the essential characters of a Gazelle, and shows a special relationship to *Lithocranius* in the form of the skull, which is unusually long in the occipital region, and has a remarkably small and slender lower jaw. Like *Lithocranius*, also, *Ammodorcas* has an extraordinarily long neck, and the female is hornless.

Clarke's Antelope is very local in Somali-land, and is not found at all in the neighbourhood of Berbera. Mr. Clarke met with it in the Dolbahanti country, between 46° and 47° east longitude in the interior, where, however, it is said to be common.

[5] Kohl, *Ann. Mus. Wien*, i., p. 82.

[6] "East Africa and its Big Game," p. 289.

[7] *Ann. Mag. Nat. Hist.*, ser. vi., vol. vii., p. 304. [8] *Proc. Zool. Soc.*, 1891, p. 207.

Besides these two aberrant Gazelles, at least three members of the typical genus *Gazella* are found in Northern Somali-land. These are the common Gazelle of the coast (*Gazella pelzelni*), the Flabby-nosed Gazelle of the interior (*G. spekei*), and the Sœmmerring's Gazelle (*G. sœmmerringi*). The ordinary Gazelle of the coast, known to the natives as "Dèro," is a close ally of the Dorcas Gazelle, and other typical forms. It seems to be abundant all over the low northern sea-board of Somali-land, which extends some 30 or 40 miles into the interior. On reaching the elevated plateau which borders this district on the south, the short-coated and brightly-coloured *Gazella pelzelni* is replaced by the long-coated and duller-coloured *Gazella*

Fig. 2.—Clarke's Gazelle, *Ammodorcas clarkei* (Reduced from *Proc. Zool. Soc.*, 1891, pl. xxi.).

spekei, which is further distinguished by the loose, flabby skin which covers the nose.

The habits of these two Gazelles, according to Captain Swayne, are nearly similar. They go about in moderate-sized herds of from six to fifteen in number, and keep to stony or sandy undulating ground, which is thinly dotted over with mimosas.

But the finest of the true Gazelles in Somali-land is the Sœmmerring's Gazelle, known to the natives as "Aoul," which attains to large size and proportions in this district. Five years ago, Captain Swayne tells us, when staying in quarters at Bulhar, he remembers seeing the Aoul, from his bungalow at that port, grazing on the maritime plain. Owing to the persecution of sportsmen they have

now retired further into the interior, but still appear to be one of the commonest of the Somali Antelopes, especially in the district of Bulhar, which lies to the west of Berbera.

We will now turn from the Gazelles to the Bubaline or Cow-like Antelopes, readily distinguishable by their long bovine heads, of which two remarkable new species have lately been discovered in Somali-land.

That an Antelope allied to the Hartebeest of the Cape, and commonly known to the hunters by that name, occurred in Somali-

FIG. 3.—Swayne's Bubal, *Bubalis swaynei* (*Proc. Zool. Soc.*, 1892, p. 99).

land and the adjoining districts, I have long been aware, but I have only recently succeeded in obtaining specimens of it, and sufficient information to warrant the bestowal upon it of a distinct name. Swayne's Bubal,[9] *Bubalis swaynei*, as I have proposed to call it, is, in regard to the shape of its horns, as will be seen from our figure, perfectly distinct from the Hartebeest of the Cape (*B. caama*), and, in fact, more nearly allied to the Tora (*B. tora*) of Upper Nubia, and to Coke's Hartebeest (*B. cokei*) of British and German East Africa, being in some respects intermediate between these two species.

[9] *Proc. Zool. Soc.*, 1892, p. 99, pl. v.

I have called this new species after Captain Swayne, who has done so much to increase our knowledge of the fauna of Somali-land, and who has supplied me with the following notes on his discovery of it :—

"South of the highest ranges of Somali-land, and at a distance of about 100 miles from the coast, are open plains, some four or five thousand feet above sea-level, alternating with broken ground covered with thorn-jungle, with an undergrowth of aloes growing sometimes to a height of six feet.

"This elevated country, called the 'Hand,' is waterless for three months, from January to March; it was crossed by Mr. James' party in 1884, when their camels were thirteen days without water.

"Much of the Hand is bush-covered wilderness or open semi-desert, but some of the higher plains are, at the proper season, in early summer, covered as far as the eye can reach with a beautiful carpet of green grass, like English pasture-land. At this time of the year pools of water may be found, as the rainfall is abundant.

"This kind of open grass country is called the 'Ban.' Not a bush is to be seen, and some of these plains are thirty or forty miles in extent each way.

"There is not always much game to be got in the Hand, but a year ago, coming on to ground which had not yet been visited by Europeans, I found one of these plains covered with herds of Harte-beestes, there being perhaps a dozen herds in sight at one time, each herd containing three or four hundred individuals.

"Hundreds of bulls were scattered singly on the outskirts, and in the spaces between the herds, grazing, fighting, or lying down.

"The scene I describe was at a distance of over a hundred miles from Berbera, and the game has probably been driven far beyond that point by now."

In Southern Somali-land, on the northern banks of the great River Tana, which may be taken as the southern boundary of this division of Africa, a still finer and more distinct representative of the Bubaline Antelopes has recently become known to science. This is Hunter's Antelope (*Bubalis hunteri*), which I first described in 1889,[10] and named after its discoverer, Mr. H. C. V. Hunter, F.Z.S. The peculiar form of the long, elevated horns of this species, and the white mark which crosses the forehead and surrounds the eyes, renders this Antelope at once distinguishable amongst its relatives. Mr. Hunter met with it on the grassy plains on the north bank of the River Tana, in herds of from 15 to 25 individuals. It frequents the plains principally, but is also met with in thin, thorny bush. Its native name is "Herota." Mr. Hunter describes it as considerably larger than the Pallah (*Œpyceros melampus*), but standing rather lower than Coke's Hartebeest (*Bubalis cokei*). Though not sloping away at

[10] *Proc. Zool. Soc.*, 1889, pp. 58, 372.

the hind quarters like a Hartebeest, it resembles that species in its heavy gallop, and belongs essentially to the same group.[11]

A third leading feature in the Antelopes of Somali-land is the presence of two Koodoos (*Strepsiceros kudu* and *S. imberbis*). The Greater Koodoo has long been known to us, and is extensively diffused over the greater part of Southern and Eastern Africa, from

FIG. 4.—Hunter's Bubal, *Bubalis hunteri* (*Proc. Zool. Soc.*, 1889, p. 58).

the Cape to the Abyssinian Highlands. Its enormous spiral horns are admired by everyone. But not so familiar to most people is the Lesser Koodoo (*Strepsiceros imberbis*), a smaller representative of the same beautiful type, which appears to be restricted to Somali-land

[11] *See* Mr. Hunter's Appendix to Willoughby's "East Africa and its Big Game," p. 290.

and the district of Kilima-njaro. The Lesser Koodoo was first discriminated as a species by Blyth in 1869. Blyth pointed out that this Koodoo differs from the larger and better known form (*S. kudu*) in its smaller size, in the absence of the fringe of long hair down the neck in front, and in the much more compressed spiral of the curvature of the horns. From the second of these characteristics he proposed to call the species *Strepsiceros imberbis*.[12] Since Blyth's time I have had the pleasure of making this beautiful antelope better

FIG. 5.—Senegal Antelope, *Bubalis senegalensis* (*Proc. Zool. Soc.*, 1890, p. 355).

known, both from preserved specimens, and from examples living in the Society's Gardens.[13]

In Somali-land, Captain Swayne tells us, the Great Koodoo keeps to the mountain ranges, while the Lesser Koodoo resorts to the bush-covered slopes at their bases. The Greater Koodoo is the largest of all the Somali Antelopes, a large bull standing about 52 inches in height at the shoulders. A good pair of its horns will measure

[12] *Proc. Zool. Soc.*, 1869, p. 51.

[13] "On the Lesser Koodoo," *Proc. Zool. Soc.*, 1884, p. 45, pl. iv.

48 inches round the spiral, but Captain Swayne has seen a pair which measured as much as 56 inches.

As already stated, the Lesser Koodoo lives on much lower ground than its larger brother, and likes to be near water if possible. It has strong hind quarters, and is a great jumper, the white bushy tail flashing over the aloe clumps as it courses away in great bounds. Captain Swayne considers the Lesser Koodoo, with its brilliant markings, as quite the most beautiful of all the Somali Antelopes.

The remaining feature in the Antelope fauna of Somali-land to which I propose to call attention is the presence of a fine species of the *Oryx* group, known as the Beisa (*Oryx beisa*), which is widely distributed all over the country. The Beisa, a very well-marked species of the group, was first discovered by Rüppell in the mountains of Abyssinia, but is now ascertained to extend all over Somali-land. In the Kilima-njaro district, where it was formerly supposed to be also found, it is replaced by a nearly allied form with tufted ears, which Mr. Oldfield Thomas has recently proposed to call *Oryx calotis*.[14]

The Beisa, as Captain Swayne informs us, keeps chiefly to open stony grounds and grassy plains, but may be found in all kinds of country except thick jungles and cedar forests. They are met with in herds of moderate size, which are chiefly composed of cows, while the bulls are frequently seen scattered singly about the country. Captain Swayne gives us an interesting account of the hunting of the Beisa by the Midgans, an outcast race, who pursue this Antelope with packs of savage yellow pariah dogs, for the details of which we must refer our readers to his interesting paper.[15]

Besides the conspicuous and more noticeable Antelopes already mentioned, several other smaller forms of this group of Ruminants are met with in Northern Somali-land, as will be seen by the following list, in which the names are given in systematic order :—

List of the Antelopes of Northern Somali-land.

1. Swayne's Hartebeest.	*Bubalis swaynei.*	"Sig."
2. Salt's Antelope.	*Neotragus saltianus.*	"Sagaro."
3. Klipspringer.	*Oreotragus saltator.*	"Alikhud."
4. Waterbuck.	*Cobus* sp. inc.	
5. Sœmmerring's Gazelle.	*Gazella sœmmerringi.*	"Aoul."
6. Pelzeln's Gazelle.	——— *pelzelni.*	"Dèro."
7. Speke's Gazelle.	——— *spekei.*	"Dèro."
8. Clarke's Gazelle.	*Ammodorcas clarkei.*	"Dibatag,"
9. Waller's Gazelle.	*Lithocranius walleri.*	"Gerenouk."
10. Beisa Antelope.	*Oryx beisa.*	"Baet."
11. Greater Koodoo.	*Strepsiceros kudu.*	"Goriali Gôdir."
12. Lesser Koodoo.	——— *imberbis.*	"Arreh Gôdir."

[14] *Proc. Zool. Soc.*, 1892, p. 195.

[15] "Field Notes on the Antelopes of Northern Somali-land," *Proc. Zool. Soc.*, 1892 (May 3rd).

In Southern Somali-land, as already shown, other species also occur, the most conspicuous of which, as yet known, is perhaps the newly-discovered Hunter's Antelope. Another fine and interesting species to be met with in the southern districts of Somali-land is the Senegal Antelope (*Bubalis senegalensis*), which appears to extend from Senegal all across Central Africa up to the Eastern Coast.[16] It has been obtained by several naturalists on Formosa Bay, and northwards as far as Kisamoyo. Sir John Kirk tells me he found it abundant on the open plains of the former locality. Grant's Gazelle and other species are likewise stated to occur on the northern bank of the River Tana ;[17] but we require much further information about the fauna of this district before a correct list of its Antelopes can be made. There can, however, be no question, I think, that, as regards Antelopes, the fauna of Somali-land is more rich and more varied than that of any other portion of the Æthiopian Region, and it seems highly probable that further discoveries have yet to be made before our knowledge of this interesting subject can be deemed complete.

P. L. Sclater.

[16] *Proc. Zool. Soc.*, 1890, p. 354.

Willoughby's "East Africa and its Big Game," p. 283.

II.

Recent Researches in Fossil Birds.

PARTLY, perhaps, owing to the difficulty of the subject itself, and in part to the comparative scarcity of their remains, our knowledge of fossil birds has not of late years advanced at the same rapid rate as has that of other branches of zoological science. The appended list of works and memoirs indicates, however, that the past year has been more than an average one as regards the work done in this branch of research.

The main difficulty connected with the subject of fossil birds lies in the circumstance that the great majority of living members of the class present such a general similarity in their plan of structure, that the differences in the skeletons of the various groups are of comparatively small degree, and are totally unlike those which obtain between the skeletons of the various orders of mammals and reptiles. It thus happens that, although it is a comparatively easy matter to assign to their proper serial position remains from the later Tertiary deposits belonging to species more or less closely allied to existing birds, yet when we descend lower in the geological scale and come across bird-remains indicating genera unlike any now living, the task of determining their affinity becomes an exceedingly difficult one. Hence we find considerable discrepancy of view as to the serial position of many extinct birds, even when considerable portions of their skeletons are known.

The aim of the work standing fifth on our list was primarily to revise and name the large series of bird-remains belonging to our National Palæontological Collection, but a survey was also taken of the whole of the known fossil birds of Europe, exclusive of those belonging to the groups of the Passeres and Picariæ. It was thus hoped that a definite land-mark might be established, from which future researches could readily take their start. Perhaps the most important point established in this work is that all the Tertiary Flying Birds may be included in the primary groups into which the Carinate order is subdivided by students of recent ornithology. The Toothed Birds of the Cretaceous rocks of North America and Europe are, however, regarded as constituting a separate series of the same Carinate order, which ranks as of equivalent value with the one containing all the modern toothless birds of flight; this conclusion being strongly supported by the view propounded by Professor D'Arcy Thompson in 1890, that the gigantic American Toothed Bird known

as *Hesperornis* is closely allied to the Divers and Loons, and has no sort of affinity with the Ostrich-like or Ratite birds, among which it had been placed.

The pride of the British Museum collection of fossil birds is (if we except the far-famed skeleton of *Archæopteryx* from the lithographic slates of Bavaria) the magnificent series of Moa bones from the superficial deposits of New Zealand, this series including a large proportion of the type specimens described by our veteran comparative anatomist, Sir Richard Owen. There was, of course, no question but that all these giant birds (the tallest of which probably exceeded twelve feet in height) belonged to the great Ratite group, which includes the modern ostriches, emus, and kiwis; but there has been considerable diversity of view as to whether all the moas should be included in a single genus, or whether they represent several generic groups. A full examination of the magnificent series of moa-bones in the Museum left, however, no doubt as to the absolute necessity of adopting the latter view. These birds were accordingly divided into five genera, of which the true long-legged moas (*Dinornis*) form one end of the series, while the short-legged elephant-footed moa occupies the opposite position, under the generic name of *Pachyornis*. The intermediate, and mostly smaller, modifications of the moa-type are arranged under the generic names of *Megalapteryx*, *Anomalopteryx*, and *Emeus*. It is of one of these smaller moas that the Museum possesses an absolutely perfect skeleton; while of others there are remains showing the skin and dried muscles and tendons still clinging to the bones. In the paper standing as No. 4 in the list given below, a somewhat different arrangement of the moas has been proposed; and there are certain points of difference in the views of the respective writers which have yet to be reconciled.

It would have been beyond the province of the work we are considering to enter into any discussion of the conflicting opinions obtaining as to the date at which the moas were exterminated. We may, however, take this opportunity of observing that it appears to us quite clear that this event was a comparatively recent one, and that if it was not brought about by the Maories themselves, it must have been accomplished by the race which immediately preceded them in New Zealand; Mr. H. O. Forbes's[1] recent researches pointing strongly to the conclusion that it was the work of the Maories.

The extraordinary profusion in which moa-bones formerly occurred in various parts of New Zealand, either strewing the surface of the ground, or buried in swamps, like the celebrated Glenmark swamp near Canterbury, or entombed in the accumulations around the ancient native cooking-places, have been long known. It has, however, been reserved for the year 1891 to reveal what appears to

[1] *Trans. New Zealand Inst.*, vol. xxiii., pp. 373, 375 (1891).

be the largest accumulation of these remains yet discovered. This "find," as we learn from a newspaper report, occurred in a cultivated field near Oamaru point in the South Island. Here, on removing the top layer of soil, an accumulation of bones was revealed, which are estimated to have belonged to several hundred individuals of various ages and species. What could have been the cause of such a vast accumulation of bird-bones in so small an area, remains at present a complete mystery.

In addition to the moas of New Zealand, the discovery of the remains of the huge *Æpyornis* of Madagascar—first made known to us by its monstrous eggs—and of those of the somewhat smaller *Dromornis* of Australia, has for many years made it a matter of common knowledge that huge Ratite birds were widely spread over the islands of the Southern hemisphere at a comparatively recent epoch. To find evidence of the existence of such gigantic birds in the European area, we have, however, to go back to the very commencement of the Eocene division of the Tertiary period—viz., the London Clay and the underlying Woolwich and Reading beds, or their continental equivalents. Thus, in England we have the genus *Dasornis* represented by a skull from the London Clay, and the allied *Gastornis* by limb-bones from the Woolwich and Reading beds near Croydon; while on the continent, in Belgium and France, the birds of the latter genus are so well represented that we now know nearly the whole of their skeleton. In spite, however, of this comparatively full knowledge of their osteology, there has been great doubt as to whether we ought to regard *Gastornis* as a gigantic swan-like bird deprived of wings, or as a member of the Ratite group. The available evidence points very strongly in favour of the latter reference; and accordingly in the Museum Catalogue these Eocene giants succeed the moas and *Dromornis*.

For some years it has been known that the Lower Eocene of the United States yields remains of an ally of *Gastornis*, described under the name of *Diatryma*, but it is only during the latter half of the past year that we have acquired definite information as to the existence of a number of apparently allied, and equally gigantic, birds in the lower Tertiaries of South America. For our knowledge of these birds we are indebted to the memoirs marked 1, 2, and 7 in our list.

In the first memoir on our list, Professor Ameghino tells us that as far back as the year 1887 he described a peculiar mandible from the lower Tertiary beds of Patagonia, under the name of *Phorusrhachos* (now amended to *Phororhachos*) which he then believed to belong to an Edentate Mammal. It turns out, however, as clearly shown by the figure given in the memoir, that this specimen is really the anterior half of the mandible of a gigantic bird; and, from the same deposits, there have now been obtained a number of the limb-bones of this and other gigantic birds, which have been provisionally described by Professor Ameghino. These remains, it is stated, indicate birds of

a totally abnormal type, and larger than any hitherto known, by the side of which the moas may be regarded as dwarfs. These huge dimensions appear to be supported by the figure of the mandible, in which the portion in front of the vacuity in the side measures more than 10 inches in length; so that the length of the whole lower jaw would probably exceed a foot. The tip of this gigantic mandible is turned upwards, somewhat after the fashion obtaining in the Agami (*Psophia*) and Chauna (*Dicholophus*) of South America. Professor Ameghino admits that he is unable to assign a definite systematic position to the bird to which these remains pertained.

In the finely-illustrated folio memoir standing seventh on our list, MM. Moreno and Mercerat, of the Museum of La Plata, give us figures of the bones of a large number of these gigantic extinct flightless birds, from the Lower Tertiaries of Argentina, which are referred to no less than nine distinct genera.

The largest of the birds described by MM. Moreno and Mercerat is designated *Brontornis*, and has a tibia measuring 30·5 inches in length. Although a bird with such a leg-bone is indisputably entitled to be called gigantic, yet such dimensions scarcely bear out Professor Ameghino's assertion that, by the side of these South American birds, the moas were but dwarfs, when we bear in mind that the largest moa has a tibia of upwards of 39 inches in length. The whole of these birds are referred to a new order, designated Stereornithes, said to be allied to the Anseres (Ducks and Geese), Herodiones (Storks and Herons), and Accipitres (Diurnal Birds of Prey). In our own opinion, these so-called Stereornithes were probably allied to the European *Gastornis*; and they serve, in any case, to indicate that, early in the Tertiary period, gigantic flightless birds were very widely spread over the continents of the world, from which they would appear, in most instances, to have retired, in later epochs, to the security of the larger islands of the warmer regions of the globe. Further light on this subject is thrown by the memoir standing second on our list, which is an especially valuable one, as showing the present state of our knowledge of the fossil birds of Argentina and Patagonia. Among the points calling for special notice, we may mention that the bird described by MM. Moreno and Mercerat as a gigantic stork, under the name of *Palæociconia*, is really a Ratite; and the name of *Prociconia* is consequently proposed for the undoubted stork from the cavern deposits of Brazil, which had been referred in the British Museum Catalogue to *Palæociconia*. A new family (Pelecyornithidæ) is proposed for a group of birds allied to the American Rheas; these having been incorrectly referred by Moreno and Mercerat to the Cathartidæ. The so-called Stereornithes of the latter writers are definitely included in the Ratitæ, and are all referred to the single family Phororhacosidæ, with only the two genera *Phororhacos* and *Brontornis*, in lieu of the host of names we have referred to in our notice of the large memoir.

The description by MM. Moreno and Mercerat of an extinct genus of Penguin (*Palæospheniscus*) in the Lower Tertiary of Patagonia is very significant, when we bear in mind that another (*Palæeudyptes*) occurs in the Eocene of New Zealand, and tends to support the view of these writers that South America was connected with New Zealand and Australia by means of an antarctic continent.

From the earlier Tertiary birds of South America, we pass by an easy transition to those of the higher Tertiary of a district in North America treated of in Dr. Shufeldt's memoir. The bird-remains there noticed were obtained from Pliocene deposits in the Silver Lake region in the south-west of Oregon. The collection is unusually extensive, comprising remains referred to upwards of fifty-one species, thirteen of which are regarded as new. Since Dr. Shufeldt's memoir is only preliminary to a fully illustrated monograph, we must reserve our judgment as to the affinities of these extinct types until the appearance of the latter. Of the collection as a whole, the author observes that it is worthy of attention that even in an horizon of Pliocene age, "many of the species were identical with those now existing, and in the case of the extinct ones, they were forms that, in the majority of instances, would not be out of place even in our present day avi-fauna, belonging as they did, in most instances, to modern genera and groups." So far, indeed, as we can gather from a perusal of the memoir, the only new genus (*Palæotetrix*) is formed for the reception of a large grouse belonging to a hitherto unknown type.

As being of a faunistic nature, the paper marked No. 6 appropriately follows the preceding one. Instead, however, of being the preliminary notice of fuller work to come, it is a *resumé* of the present state of our knowledge of the fossil birds of Britain. A reference (in many cases necessarily very brief) will be found to every species hitherto recorded from that area. As the total number of species mentioned but slightly exceeds sixty, of which some forty-five are still existing, it is manifest that there is yet much work remaining to be done (if materials are but forthcoming) before we can be said to have acquired any adequate knowledge of the British fossil birds of even one geological epoch.

We have reserved to the last our notice of the memoir standing third on our list, not for the reason that it is by any means lacking in interest, but because it treats of only two species which have but little connection with any of those hitherto mentioned. More or less nearly complete skeletons of birds from the Upper Eocene gypsum quarries of Montmartre, on the outskirts of Paris, have been known since the time of Cuvier. These are, however, of comparative rarity, and in some cases are in a condition not admitting of satisfactory determination. The two skeletons described by Dr. Flot are, on the other hand, in an excellent state of preservation, and are of special interest from a distributional point of view.

In his classic work on the fossil birds of France, Professor A.

Milne-Edwards proposed the name *Laurillardia* for a bird represented by an imperfect skeleton from Montmartre, which had been tentatively placed by Cuvier among the Picarians. That this bird was not a Picarian appeared indisputable to M. Milne-Edwards, by whom it was transferred to the Passeres, with the suggestion that it might be allied to *Promerops*. The two skeletons described in the memoir before us are found by Dr. Flot to belong to the genus *Laurillardia*, of which they indicate two new species. A careful study of their structure reveals the fact that these skeletons belonged to a bird closely allied to the thrushes, but with shorter feet. On comparison with recent birds, the only one which presents a similarity is the rare *Hartlaubia* of Madagascar, commonly known as the Madagascar Thrush. That bird is a peculiar intermediate type, having the habits of a starling and the structure of a thrush, although the feet are smaller than in the true thrushes. There is, accordingly, no doubt as to the close alliance of *Hartlaubia* and *Laurillardia*, the latter being distinguished by its more powerful beak and shorter leg-bones: the proportions of the latter approximating the extinct genus to the Picarians. Similar Picarian features are exhibited by the limbs of the aberrant Madagascar starling-like bird known as *Euryceros*.

We thus have evidence, observes Dr. Flot, "at the epoch of the Paris gypsum, of the existence of birds intermediate between the thrushes and the starlings, allied to the syndactylous Picarians by the proportions of the leg and foot, but true Passerines as regards the arrangement of the toes, and represented at the present day by the Madagascar Thrush." *Hartlaubia*, it may be added, is a bird of slow and clumsy build, which could only be expected to survive in a region where the struggle for existence was not so severe as it is on most of the continents. The lemurs and civets of Madagascar have already suggested a comparison of the mammalia of that island with those of the Upper Eocene of France; and we now have evidence of a distinct connection between the bird-faunas of the two areas.

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R. LYDEKKER.

III.

The Cave Men of Mentone.

THE Mentone Caves and their contents have been well-known to Geological students as subjects of controversy during the past twenty-five years, and the recent discovery of new skeletons there will arouse a fresh interest in a locality that has been regarded hitherto as somewhat unsatisfactory. As the future of the specimens in question is very doubtful, owing to disputed ownership, atmospheric influence, and the destructive agency of the tourist's umbrella, it may be of some use to record at once the leading facts concerning the remains discovered.

In the mass of Lower Cretaceous Limestone to the east of Mentone, forming the cliff called the Red Rocks, lies the series of Caves of Baoussé Roussé[1] (Balzi Rossi), situated on the Italian side of the stream and valley that constitute the frontier. The best known skeleton from this district, found by M. Rivière in 1873 and figured in many text-books, was discovered in Cave 3, counting from west to east (Cave 4 of M. Rivière). It is Cave 4 (referred to as 5 by M. Rivière) that has yielded the skeletons of 1884 and 1892. We are at present concerned with this one only.

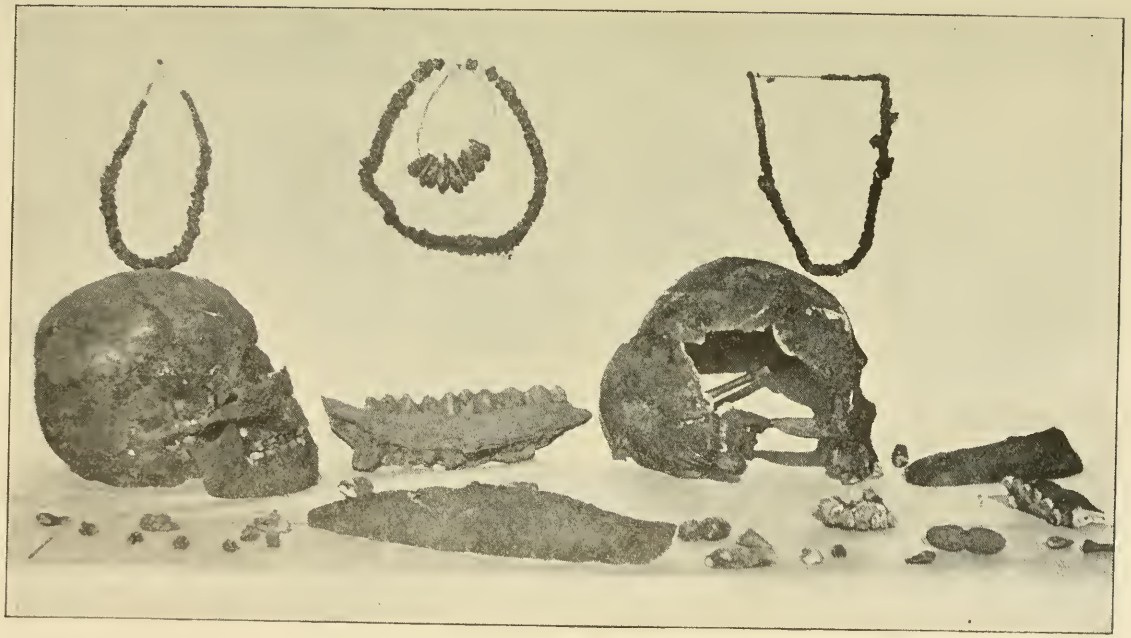
The mouth of this cave is in a wall of sea-cliff, quarried for stone, about 30 or more metres from the present sea-margin. It seems, on inquiry, that the west side of the present cave-mouth has been in much the same position for many years, though the east side has been a good deal cut back by quarrying.[2] The cave itself is a great vertical cleft, measuring some 25 metres in length by 3 to 6 metres in width. The walls converge till they meet about 15 metres above the present floor. Before any excavations were made the cave-floor was at the mouth six metres higher than now, and the present floor is simply the level at which former excavations ceased. Moreover, as noted by M. Forel in 1858, the floor had even then been lowered by natural agencies, as shown by ossiferous incrustations clinging to the walls.

Of the nature of the mass of material already removed, and the

[1] A description of the contents of the caves will be found in M. Rivière's papers, "De l'antiquité de l'homme dans les Alpes Maritimes." Paris, 1878–1886 (Ballière).

[2] This has to be borne in mind in trying to fix now the position in which the 1884 skeleton was found.

TO FACE P. 272.



HUMAN SKULLS, ORNAMENTS, IMPLEMENTS, AND ANIMAL REMAINS FOUND IN THE CAVERNS OF MENTONE, FEBRUARY, 1892.

[*From a Photograph by M. Bertrand, of Mentone.*]

The skull on the right belongs to the largest skeleton (No. 1), and that on the left to No. 3. Above are shown the necklaces of perforated teeth and fish-vertebræ; in front is the largest of the flint flakes; and to the right is the bone ornament. There are also teeth and fragments of jaws of auroch found near the human skeleton.

level at which bones and implements have been found, there is little accurate information to be obtained on the spot. M. Forel's specimens (1858) were scattered through a superficial layer half a yard thick, and included remains of the stag, roe, sheep, antelope (?), auroch (*Bos primigenius*), horse, boar, wolf, fox, cat, rabbit, cachalot (?), with mollusca (*Dentalium*, *Patella*, *Pecten*, and *Pectunculus*), also arrow-heads, fish-hooks, spear-heads, and knives of rough make and not more than two or three inches long. All these were in the surface layers.

Between the years 1866–1886 the great mass of the cave-contents was removed to a depth of six to eight metres by MM. Rivière, Bonfils, and others. The whole thickness consisted of loose earth, much of it of vegetable origin, without any layers of stalagmitic deposit. We have no data for estimating the rate of accumulation of such material, but it is evident that the time required must be very great. Flint implements were found in numbers throughout, mostly small and rough flakes of uncertain age; but it is important to note that no pottery of any kind occurred. In this connection the occurrence of remains of extinct animals, even in the higher layers, should also be borne in mind. One of the most interesting of these is the skull of an ancient species of Marmot (*Arctomys primigenia*), indicating a far colder climate.

The skeleton of 1884 was found just inside the cave-mouth (close to the position of the present relics) at a depth below the original floor of 8 metres 40 cm. It was lying on its back, between the cave-wall and a large stone, parallel to the long axis of the cave and with the head towards the entrance. The depth from the old floor-line is somewhat more than my estimate for the present discovery; but as the cave is here only 3 metres wide, it is very difficult to see how the discoverers of the older example could have missed the present specimens if they excavated to a greater depth. Allowing the maximum depth for the position of this skeleton and the minimum for those of 1892, there is not more than a yard of difference in position between them.

It was on February 7th, 1892, that the quarrymen then at work discovered on the east side of the cave at a depth of $7\frac{1}{2}$ metres (below the original floor) three skeletons close together near the cave-mouth. They lie only $1\frac{1}{2}$ metres below the present floor, and this thickness is composed of soft earth and stones which have probably been turned over before, though, curiously enough, without discovering the skeletons. The bed on which they rest is scarcely harder in texture, but redder in colour, and the bones and ornaments are strongly tinged with red. Below the skeletons is still a deposit of dark earth with stones, similar to that above. There is an evident stratification, and the deposit has not been disturbed before. Here have been found several flint-flakes and some rough, pointed and polished bone awls; but as there is little of this stratum left, not much is to be expected from its further excavation.

Although the skeletons had doubtless been buried, there is nothing to show that any special tomb had been made; and owing to the removal of almost all superincumbent strata and the *remanié* character of what is left, it is impossible to say how far the overlying layers had been disturbed. Still, it is not likely that neolithic sextons with flint spades could dig more than five or six feet to dispose of the remains of a fellow-man even of seven feet length, and one may take it as certain that the period that has elapsed since the interment is represented by at least 15 or 16 feet of deposit.

The outermost skeleton is lying on its back, and measures just 2 metres from the end of the toes to the position of the collar-bone. Deducting for the foot and measuring from the heel, with addition for the head and neck, the height must have been seven feet at a low estimate.[3] The arms were lying at the side, the left hand resting over the head of the femur and enclosing a flint implement. By March 15th, when the present writer first saw the remains, the skull had been removed; the arms had disappeared, all but part of the left humerus and ulna, and there was no trace of shoulder bones or ribs. The pelvic bones had also been removed, as well as the sacrum; but 14 vertebræ could be counted in position.

The other two skeletons are smaller, measuring little over six feet in length, and both lie on the left side, the legs turned forward and bent slightly at the knee. The arms are bent so that the right hands come to a level with the shoulder. The second implement was found in the hand of the middle skeleton, the third under the head of the innermost.

The left arm of the third was not bent up, but the hand was lying by the ilium of No. 2. This arm has now disappeared.

As regards the skulls, the middle one has been entirely destroyed, while the others are much damaged. The first (1) is of size proportionate to the skeleton, and enough remains to show some general characters, though the left side, the jaw, and the basis cranii are wanting. The maximum length is 21 cm.; and the greatest width in the parietal region is 15 cm.

The cephalic indices are therefore 71·5 and 66·5, the former very near that of the 1884 skull, determined by Mr. Wilson[4] as 71·35, and near those of Cro-Magnon. The craniofacial angle is not easy to determine, owing to the destruction of the occiput and basis cranii, but it seems to be approximately 90°. There is a distinct prognathism about the former.

The contour of the two crania is different. The larger skull (1)

[3] The height measurement given by M. Rivière, 1·85 (=6 ft. 2 in.), is certainly below the mark, and was calculated from the femur. That given in some papers of 2·0 metres (or 6 ft. 8 in.) without the skull, is too large, as it is taken from the end of the toes. The exact measure will probably never be known, as the neck and shoulder region is now destroyed. M. Rivière's note on the 1892 skeletons was read to the Paris Academy of Sciences on March 7. I know it only from a newspaper report containing several inaccuracies.

[4] Brit. Assoc. Rep., 1885, p. 1218.

is higher in the parietal region, and projects to a remarkable extent above the occipital region, so much so that it is, perhaps, abnormal. The smaller skull is highest in the posterior parietal region; it is, moreover, curiously asymmetrical, the right parietal region being much flattened, and the left higher and more convex.

All the skulls, then, are dolichocephalic, and one of the new ones closely approaches that of 1884. The three may be placed in series. That of 1884 has the more prominent supra-orbital ridges and projecting chin, and is widest in the frontal region. The large skull of 1892 has the prominent eyebrow-ridge, but is slightly narrower in the frontal region. The smaller skull has these prominences less marked, and is narrower across the frontal bones, but still stronger, thicker, and more definitely ridged than the neolithic skull of Final Marina referred to below. All have the somewhat quadrangular-shaped orbit relied on by M. Rivière as evidence of antiquity.

The lower jaw (complete only in No. 3) is very broad in the chin-region, and wide at the side in the area of attachment of the masseter muscle.

The teeth in the larger skull, so far as left, are well worn down, and the crowns are flat, indicating an advanced age for the individual in question. In skull No. 3, on the other hand, the teeth are little worn, and the last molar has not yet come into use, showing that the age of the individual was not more than 20 years. The third skeleton has been said to be that of a child, but as it is quite as large, there seems no reason for attributing to it a younger age than the second. The skull has been lost.

Whatever, then, are the differences between the individual skulls found at different times in the Mentone Caves, it is of importance to note that they are as a whole widely separated from such types as that found further east in the Final Marina Caves, and now in the Museum at Bordighera. Though full details as to the position in which this specimen was found are not yet obtainable, it may be mentioned that the skull, while dolichocephalic, is much smaller, the supra-occipital region weak, the zygoma slender, and the jaw feeble in comparison; a series of craniological deficiencies which may or may not be correlated with the fact that the skeleton is associated with well-made and ornamented pottery, of which no trace seems to have been found at Mentone. The beautiful preservation of this specimen, which I have had the opportunity of examining through the kindness of C. Bicknell, Esq., suggests that it may be of very late age; it is only referred to here as a type of skull without any of the "Cro-Magnon" characters.

The implements found with the skeletons are larger than those discovered round the 1884 cranium,[5] and also thinner and

[5] These were 6–7 inches long, thicker and without curvature, but at the same time not much wider in proportion, as is the case with so many typical Palæolithic flints.

more curved. They are also two or three times as large as anything found in overlying deposits. The largest measures $10\frac{3}{8}$ inches (26·3 cm.) in length by $1\frac{3}{4}$ (4·5 cm.) in width, and is remarkable both for its thinness (not reaching $\frac{3}{4}$ in.) and its strong curvature. The others measure respectively 23 by 5 by 1·5 cm. and 67 by 5·5 by 1·3 cm., and are also thin, though the curvature is less marked. All are roughly chipped, and show no trace of polishing. Though implements of this character occur with relics of Neolithic date, yet they are by no means distinctively Neolithic. Similar ones occur in France in the Magdalénian period, and in the British Museum there are undoubted Palæolithic fragments of equally large flakes.

A necklace of perforated teeth was discovered round the head of the large skeleton. All the teeth are ground down and polished, and many are ornamented by transverse striæ, so that all distinctive characters in the crowns are obliterated. M. Rivière's opinion that they are canines of deer is probably true of the greater number. The perforations are central between crown and fang; they are cleanly cut and polished, considerably wider at the surface than the centre, as is usually the case with holes bored by flint flakes.

The fish-vertebræ are of rather small size, scarcely exceeding a centimetre in diameter, and are perforated through the axis by holes a millimetre in width. They were found round the necks of all three skeletons and seem to belong to the genus *Salmo*.

Two Cowrie shells perforated just at the anterior end of the mouth were also found, and seem from their position to have been used as anklets. The species is not, I believe, a Mediterranean one, but seems to be identical with an Atlantic form in the Mentone Museum, labelled *Cypræa millepunctata*, though colour and marking have disappeared. M. Rivière refers also to a necklace of small shells of *Nassa* similar to those found with the skeleton of 1873, but it has now disappeared.

The bone ornaments discovered were three in number, lying on the forehead of the skulls, and had been, doubtless, attached to the thong on which the teeth were threaded. All have the form of a spindle, deeply constricted in the middle, with a smoothed surface ornamented by rows of short transverse lines. One measured 2 by $\frac{5}{8}$ in., the others, one larger and one smaller. Internally the texture is somewhat cancellous. M. Rivière is of opinion that they are made from stag's horn.

Coming to the question of the age of the new skeletons, one is confronted with the same difficulties that have attended other discoveries in this region. What importance is to be attached to great thicknesses of cave-deposit when there are no stalagmitic layers to mark particular levels? To what depth are we to suppose Neolithic man could dig graves? How much value is to be attached to the manufacture of ornaments, and how much, on the other hand, to cranial characteristics?

Such skeletons as that already referred to of Final Marina, are of distinctly later type, and associated with a considerable quantity of pottery, grinding stones, &c. Those of Mentone have, it is true, well-worked ornaments and long, narrow flints; but no pottery has been found, and the only relic suggesting a Neolithic age is an axe in the Museum of St. Germain, noticed by Boyd Dawkins in his "Early Man in Britain," p. 229.

The skeleton of 1884 has been regarded by Mr. White, M. Bonfils, and M. Vaucardard as Palæolithic, and they say rightly enough that it is very difficult to suppose the Neolithic men could have dug graves with hands or flints even to five feet, much less to twenty feet. Mr. White, who lays much stress on this point, seems to suggest that the interment must have taken place from the recent floor; but, although that is, of course, not the case, still allowing five feet for the grave there remains an accumulation of some sixteen feet as a monument to the passage of years in Neolithic times.

The cranial characters of the 1884 skull have much in common with the older types of skulls elsewhere. The strong supra-orbital crests, the projecting occiput, wide facial angle, and powerful mandible, are all such features as occur in well-known skulls of older periods. M. Mortillet passed over these characters lightly, attributing the skeleton to the Neolithic time on the strength of the pointed bone implement found near it; and many English writers have similarly denied the antiquity of the Mentone specimens.

Whatever arguments were used for and against the ancient date of the 1884 skeleton, might be used with regard to the present ones in general. The mere fact that the superincumbent 25 feet consisted of soft, more or less overturned earth, so that different horizons either never existed or are gone past recovery, may justify writers in neglecting to attach importance to the remains. Still, we must feel either that post-Neolithic deposits may be of very great thickness, or that the relative value of osteological characteristics and manufactured ornaments is not yet well defined. Now that new skeletons have been found at a well-ascertained level (though interred), it is important that their cranial and all other characters should be carefully investigated. Cave-specialists who are accustomed to have their stratigraphical horizons neatly marked out for them by providential layers of stalagmite-flooring should not be allowed to avoid giving an opinion on other characters when such data are unattainable.

The size of the 1884 skeleton might be exceptional, but the present examples suggest that it may have been characteristic of the race buried at a certain period. The 1884 skeleton had buried with it a large number of short, wide flint flakes about 1½ inches in diameter, as well as the three large implements already referred to; and these smaller ones have a distinctly Palæolithic aspect. With the

1892 skeletons the ornaments are much more finely polished and bored than would be expected in association with the Palæolithic type; but at the same time it must be borne in mind that if Palæolithic man had such artistic capacity as we know he possessed from the classic drawings on bone, it is not difficult to suppose he could perforate teeth for necklaces. It is, on the whole, easier to imagine that man learned the art of making necklaces at an early date, than to suppose that the Mentone skulls belong to the age of polished celts and pottery. One can more readily believe that relatively sudden changes took place in man's technical power in one region (for instance, by learning of other races) than that any rapid change in the forms of skulls occurred. The mere absence of ornaments from the skeleton of 1884 is of little value in discussing its age, though it may tend to indicate the poverty or inartistic character of the subject. The implements, again, though not of the type which we in England know as Palæolithic, are certainly not any of the usual Neolithic patterns. In size and shape they differ markedly from anything found in the overlying deposits, and their value was, doubtless, the reason for burial with their owners.

That the new skeletons, therefore, may well belong to the Neolithic age is possible, and the worked ornaments with them point to that conclusion. But at the same time they show osteological affinities to more ancient types. It seems probable, also, that the 1884 skeleton belongs to the same period, and that its great size was not an isolated accident; while it appears that the deposits which can be formed in a cave where there is no stalagmitic deposition may reach a thickness of 16 feet or more, accumulating since the age when the art of working bones had been perfected. Furthermore, it is likely that the habit of speaking of Palæolithic and Neolithic times, and attempting to draw sharp distinctions between them, carries with it more than the usual evils of all formal nomenclature.

The Mentone skeletons, perhaps, belong to a transition period, when the race of cave-dwellers were of large size and of ancient skeletal build, when they made roughly-chipped implements, and were ignorant of the art of pottery manufacture. On the other hand, they knew how to work bones and to make necklaces of them, and they had, apparently, a definite custom of burial.

It should be stated, in conclusion, that these notes were written on the spot, where reference to books and comparison with other skulls were alike impossible, and that, therefore, too much stress may be laid here on cranial characters. On the other hand, the fact that precisely similar perforated teeth, vertebræ, and shells of *Cypræa* have been found in the Dordogne caves of the same age as the classic drawings on bone of mammoth and reindeer (a fact of which at the time the writer was ignorant), strengthens very much the argument for the Palæolithic age of the Cave Men of Mentone.

A. VAUGHAN JENNINGS.

IV.

Facts and Theories in the Development of Insects.

REFERENCE was made in NATURAL SCIENCE for March (pp. 55, 56) to the Stylopidæ. These insects were formerly regarded as a special order (Strepsiptera), but most entomologists now consider them to be a very aberrant group of Beetles (Coleoptera) related to the Oil Beetles (Cantharidæ) and the Rhipiphoridæ. In both these families the larvæ live parasitically on the grubs of bees and wasps. In the Stylopidæ we see the parasitic habit continued in the female imago, and such modifications in the male that its coleopterous affinities are much obscured. Moreover, the host is not prevented from attaining its imaginal state; indeed, it must be allowed to do so to secure the fertilisation of the parasitic female *Stylops* by her free-flying mate.

Although many species of Cantharidæ and Rhipiphoridæ are known, the life-history of few only has been worked out. The classical researches of Newport and Fabre long ago made known the "hypermetamorphosis" of *Meloë* and *Cantharis*, which belong to the former family. In 1870, Dr. Chapman and Mr. Murray (1) discovered the transformations of *Rhipiphorus paradoxus*, the larva of which they proved to be first a minute active hexapod, then an internal and then an external parasite on the grubs of the social wasps (Vespidæ). And now Dr. A. Chobaut (2) has worked out most of the life-history of another beetle of the same family, *Emenadia flabellata*, belonging to a genus unknown in Britain, and with very few European species. He has shown the great similarity of its transformations to those of *R. paradoxus*, and finds that its hosts are the grubs of a species of solitary wasp (*Odynerus*).

Three *Odynerus* grubs were found within the cavity of a reed, each in its cell closed by earthen walls, as is the habit of the wasp in making its nest. The grubs did not pupate in May, the usual season; but early in June a parasitic larva emerged from each, and fed incessantly for twelve days, sucking at the ventral region of its host until only the skin and mandibles of the latter were left. This parasitic larva is described as entirely without legs, eyes, or antennæ, and with a suctorial mouth.

Four days later these larvæ pupated, and from the form of the pupa Dr. Chobaut decided that they were beetles of the genus *Emenadia*. Early in July the perfect insects were produced—a male and two females, of the species *E. flabellata*. One of the females laid fertile eggs in the middle of July, from which, early in August, were hatched active larvæ of extremely small size, with large head, with a pair of antennæ inserted near the base, the thorax with six well-developed legs, and the abdomen of nine segments, the last two being each provided with a pair of long filaments.

The place in which the female lays her eggs in the natural state, and the details of the transition from the hexapod larva to the legless parasite, have yet to be determined. Dr. Chobaut suggests that the eggs are laid in the earth, and that the hexapod larva attaches itself to the hair of the wasp, which carries it to the nest. The researches of Messrs. Chapman and Murray, however, on the life-history of *Rhipiphorus paradoxus* tend to the conclusion that the beetle lays her eggs in the cells of the wasp's nest.

The hexapod larva of *Emenadia* closely resembles that of *Rhipiphorus*, as described by Dr. Chapman, except that the latter appears to be without the long filaments on the two hinder abdominal segments. Dr. Chapman describes the *Rhipiphorus* grub in its parasitic stage as carrying on its white skin the black chitinous plates of its former hexapod condition, widely separated by the growth of the insect. "These plates," he writes, "may be regarded as a beautiful display of the dermal anatomy of the little active larva." Such plates, however, were not observed by Dr. Chobaut on the grub of *Emenadia*. In all these beetles we find an active hexapod larva preceding the legless parasitic grub. This indicates that the larvæ of the ancestors of these beetles were free-living. A similar hexapod larva is found in some other groups of insects; from its likeness to the adult *Campodea* it is often called "campodiform." As *Campodea* belongs to the most primitive group of living insects (Thysanura), it has been held by Brauer, Lubbock, and most other entomologists, that the occurrence of a campodiform larva as the earliest stage in the post-embryonic life-history of various insects points to the descent of our modern insect groups from a campodean ancestral stock. Further, the fact that some Myriapods have but six legs in their early stages has suggested the derivation of that class also from a similar stock. The vermiform insect larva, of which the caterpillar of a moth is a familiar example, has been generally regarded as a form which has become secondarily modified to meet the requirements of its special mode of life. The pairs of pro-legs present on some of the abdominal segments of a caterpillar have been thought to be not homologous with the six thoracic legs; and it has been considered that moths, no less than beetles, are descended from campodean ancestors. The primitive campodean itself must have been derived from a vermiform ancestor, and therefore the caterpillar has

been regarded as an instance of atavism, of retrogression towards the form of an extremely remote progenitor.

The primitive nature of the campodiform larva has, however, now been called in question by Cholodkowsky. In the concluding section (on the morphology and phylogeny of insects) of his recent paper (3) he reviews the latest researches on insect embryology. He states that Kowalevsky and Tichomirow have described appendages on the abdominal segments of the embryos of moths (*Smerinthus populi* and *Bombyx mori*). Graber also described abdominal appendages in the embryo of *Gastropacha pini*, but considered them secondary structures because of their late appearance. Now, Cholodkowsky believes that these embryonic appendages disprove the derivation of the caterpillar from the campodean larva, and establish the homology of the pro-legs with the legs of the thorax. On the other hand, he does not consider the vermiform larva to have given rise to the campodean, because the most primitive winged insects (Orthoptera) have only six legs in their young stage. The conclusions seem to be, that the two kinds of larva have arisen independently of each other, that all insects are derived from a remote many-footed vermiform ancestor (as forms with a campodean larva have abdominal appendages in the *embryonic* stage), but that only some groups can be descended from a campodean ancestor. The entire class of insects is more nearly related to the Myriapods than to any other group of Arthropods.

Many questions of great interest are discussed in this work of Cholodkowsky. He has observed appendages on all the eleven abdominal segments of the embryo cockroach, and he concludes that all these are homologous with the legs and jaws. The appendages of the four hinder abdominal segments become the gonapophyses and cerci of the adult insect, the cerci being the limbs of the hindermost segment. It hence appears that these organs had an ambulatory function in the remote worm-like ancestors of the class.

One of the most startling of Cholodkowsky's conclusions is his interpretation of the insect-head. He states that this consists of certainly more than four, probably six, segments of which one only is pre-oral, and that the antennæ are the appendages of the first post-oral segment. The pre-oral origin of the antennæ of insects has seemed so firmly established during the last few years that this statement will not be received without further confirmation. The contradictory statements already made by various observers on this point are proof of the difficulty of determining whether the embryonic antennæ really arise before or behind the mouth, and Cholodkowsky's own figures do not seem conclusive on the subject. However, he states that there is doubtless an antennal mesodermal somite (clearly figured), and that the rudiment of the antennal ganglion arises behind that of the pre-oral ganglion with which it afterwards fuses.

Should this post-oral origin of the antennæ of insects be established, they will have to be regarded as the homologues of one of the

pairs of antennæ of the crustacea. Cholodkowsky suggests the second pair, though the first pair have been regarded as post-oral by most observers. The generally received view is that insect antennæ, being pre-oral, have nothing to do with those of crustaceans. We must also consider the chelicerae of arachnids homologous with the antennæ of insects, if the latter are really post-oral, instead of with the mandibles, as has hitherto been believed. Indeed, our comparison of arthropod limbs seems to be once again uncertain, especially as small appendages have been described by various observers between the antennæ and mandibles of some insect embryos. Further and more careful researches on a number of types must be undertaken before this fascinating subject of arthropod homology will be settled. Fascinating, indeed, it is to see an undifferentiated limb of the far-off ancestor of the race in one group changed into a jaw for seizing and poisoning prey, in another into an organ of exquisite and mysterious sense.

The fate of the primitive body-cavity, or cœlome, is also discussed by Cholodkowsky. In each segment the cavity divides into three parts. The dorsal part (in some abdominal segments) contains the rudiments of the genital glands;[1] from its wall is formed the muscular coating of the intestine. The lateral part disappears. The ventral part becomes filled with the developing fat-body and loses its boundaries; it is believed to be homologous with the segmental organ of *Peripatus*. This seems probable, and, if established, will be a highly interesting result. It seems certain that the body-cavity of the adult cockroach has nothing to do with the primitive cœlome, but is a "pseudocoel." In Sedgwick's well-known paper, in which he proved this result for *Peripatus* (4), he suggested that the same would probably be established for other Arthropods, and we now have a striking confirmation of his views.

In the cockroach and most other insects, the ventral surface of the embryo where the appendages are being developed, is covered by two membranes, the outer of which is known as the serous membrane and the inner as the amnion. In the embryo of the ichneumon fly (*Mesochorus splendidulus*, Grav.) Kulagin (5) states that these membranes are not formed. In that of another ichneumon (*Microgaster glomeratus*, L.) they are represented only by a small fold at the hinder end of the body. This latter fly lays its eggs in the bodies of the caterpillars of the Cabbage White Butterfly (*Pieris brassicæ*, L.), and hence it has a strong economic as well as scientific interest. The last segment of the parasitic larva has the shape of an inflated bladder, and seems to possess an excretory function.

Observations on the life-history of another ichneumon fly (*Perilitus brevicollis*, Hal.) were made in Algeria by MM. Künckel

[1] The genital cells are believed by Cholodkowsky to be formed from yolk cells, but, as stated in NATURAL SCIENCE for March (p. 55), this is contradicted by Heymons.

d'Herculais and C. Langlois (6). This fly was described by Haliday in 1836 from a single specimen captured in the north of Ireland. Since then only four more examples had been taken, one in Germany and three in England; but now the insect has been found in myriads in Algeria, attacking with great effect the larval and perfect stages of a beetle (*Haltica ampelophaga*, Guèr.) which is extremely destructive to vines.

The parasitic grub of the ichneumon feeds singly within the larva of the beetle, avoiding the vital parts but devouring the fat-body, and thus rendering further development impossible. Fifty to eighty out of every hundred beetle-larvæ examined were affected, and the adult beetles are also liable to be attacked. The value of this parasite to owners of vineyards is evident, and we have another instance of man's best allies against the insect-destroyers of his crops being themselves insects. The study of the development of insects not only enables us to speculate on the nature of their far-distant ancestors, but teaches us how in some measure to save from destruction "the kindly fruits of the earth."

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Geo. H. Carpenter.

V.

Phosphatic Chalk.

NEARLY a year has elapsed since the occurrence of phosphatic chalk in England was first announced (1). Though an exactly similar rock had been extensively worked for some years in the north of France and Belgium, with the result of an enormous increase in the value of the land where it occurred, yet it had never been recognised on our side of the Channel; notwithstanding which it had lain open to view for many years in an old chalk-pit hardly more than twenty miles from London. This seems the more strange, in that the appearance of the rock to the naked eye is sufficiently marked to attract attention, while under the microscope its character is unmistakable; for the deposit consists almost entirely of phosphatised foraminifera in beautiful preservation, together with fragmentary fish-bones, fish-scales, and minute coprolites. These organisms are embedded in chalky mud containing coccoliths and discoliths, and impart to the rock a granular or sandy appearance, and a pale-brown tinge which at once distinguish it from smooth white chalk of the ordinary type.

New discoveries of phosphatic chalk are being made from time to time on the Continent, yet an old chalk-pit at Taplow remains the one known section of such a rock in England. That this is actually its sole occurrence in this country seems scarcely probable. Yet our Chalk, of late years especially, has received much attention from both Foreign and English geologists, and the principal subdivisions into which it can be separated are being traced throughout the country, not only by the Geological Survey, but by men who have made its study a speciality, and who are unlikely to overlook the least variation in its lithological character. Many landowners, moreover, keenly alive to the possibility of increasing the value of their property, from time to time bring forward specimens which seem to correspond to the description given of the Taplow Chalk. All this notwithstanding, we cannot produce so much as a single phosphatised foraminifer outside the limits of the old Taplow chalk-pit. Why this should be, and what should be our guide in the search for fresh deposits, are questions that await an answer.

From the accounts given of the Continental deposits, we learn that phosphatic beds are never continuous at any horizon in the Chalk for more than a short distance. Thus, in one of the latest

papers on the subject (2), we are told that of all the deposits yet discovered, even those with a cubic capacity of more than a million metres, every one has been proved to be lenticular in form. The greatest length of these lenticular beds rarely exceeds one kilometre (1,100 yards), and their breadth two or three hundred metres, while in thickness the phosphatic rock ranges from nothing at the edges of the lenticle to upwards of twenty metres in its central portions. This, then, is the probable explanation of the fact that even at Taplow the deposit has not been recognised beyond the pit and its immediate surroundings. It is, doubtless, of a lenticular form, and probably of no great extent. The other pits and sections in the neighbourhood, which are neither numerous nor conveniently situated, seem in the few cases where they expose the right zone in the Chalk to lie beyond the limits of the lenticle. What these limits are, and in what directions the lenticle extends can only be determined by borings or by tunnelling from the known outcrop, either of which operations would entail a greater expense than would be repaid by the working of the deposit in the present state of the phosphate market.

The study of a rock, however, by geologists is little influenced by its price per ton, and any new discoveries of this interesting variation of the ordinary type of Chalk will receive due attention. But where the next find will be made becomes more uncertain as time passes. The Belgian phosphate occurs at a higher zone in the Chalk than is known to exist in this country. The French deposits, on the other hand, though not strictly on one horizon, lie high up in the Upper Chalk of English geologists, and at or near the horizon of the Taplow Chalk. In our locality this horizon lies close beneath the Tertiary beds, but in other districts, and even in the immediate neighbourhood of Taplow, these strata rest upon other parts of the Upper Chalk, either higher or lower than that in which the phosphatic beds are situated. For the country generally, therefore, we require a surer guide than that afforded by the Tertiary boundary.

The Chalk at first sight presents so great a sameness from top to bottom that an unpractised observer would have little chance of distinguishing one portion of it from another. It can, however, be divided by lithological characters and fossil-contents into three generally well-marked subdivisions, known as the Upper, Middle, and Lower Chalk. The lower limit of the Upper Chalk is drawn at a nodular bed, not only conspicuous from its hardness and other peculiarities, but capable of being traced over a large part of the country, and of being laid down with accuracy on the Geological Survey maps; which, in fact, has already been done over considerable areas. In the Chalk Rock, therefore, we shall have a definite base-line from which to reckon upwards in a search for the zone where phosphatic chalk may be expected to occur. Some further assistance may be rendered by the existence of zones in the Upper

Chalk, characterised by certain fossils. On the Continent this subdivision of the Upper Chalk has been carried out with some completeness, but in England the boundaries of these zones are too indefinite for use by the geological map-maker. So far, therefore, as maps are concerned, we shall have to depend on the Chalk Rock as our principal guide in estimating our position in the Upper Chalk. At Taplow, the phosphatic zone is believed to lie about 250 feet above the Chalk Rock.

The much debated question as to the origin of the phosphatic chalk has not received much light from the most recent communications. We are asked to believe that the phosphoric acid rose from the rocks below the Chalk through hypothetical fissures, along anticlines which have not been proved to exist. Why, if the acid rose from below, should portions of the Upper Chalk have been acted on, and all the lower parts of the formation left unaltered? Nor, on the other hand, has any connection between the Tertiary beds and the phosphatised zones been established. At Taplow, twenty feet of ordinary non-phosphatic chalk intervenes between the Tertiary base and the highest phosphatic beds. We are driven, therefore, to the conclusion that the phosphoric acid is one of the original constituents of the rock in which it now occurs. We may infer, moreover, from the fact that foraminifera in the same condition of mineralisation as those which compose the phosphatic rock have been detected in flints in some of the foreign deposits, that the shells were phosphatised while they lay at the bottom of the chalk-sea, and probably soon after the death of the occupants.

MM. Renard and Cornet, in their exhaustive paper on the Continental phosphatic chalks (3), remark that the mode of occurrence of the granules points to their having been accumulated under the action of currents. The minute fragments of scales and bones, being of the same material and of about the same size as the phosphatised foraminifera, would be carried with them. The Chalk, in their opinion, is not a deep-sea deposit, but a sediment laid down in comparatively shallow water at no great distance from land; and these granules are such as could be transported a considerable distance by ordinary marine currents. Animal-life occurs in the greatest abundance near shores; and to the reptiles and fishes of the littoral zone these authors attribute the concentration of phosphatic material, and the subsequent phosphatisation of the microscopic organisms with which it was mingled.

The Taplow Chalk also is clearly a sediment such as might have been distributed by marine currents. To the naked eye, indeed, it much resembles a somewhat chalky sand. The theory that it was drifted from a distance to its present situation explains also the fact that the larger organisms, such as Belemnites and fragments of *Inoceramus*-shell, though embedded amongst phosphatic granules, are not themselves phosphatised. Yet the characteristically-shaped

prisms, yielded by the complete disintegration of the *Inoceramus*-shell, form separately a large proportion of the phosphatic granules. Hence, we may suppose that phosphatisation took place before the drifting of the materials, and that only those organisms which were originally small, or which had been broken down to the requisite size, were transported.

On the other hand, we find difficulty in supposing the Taplow Chalk to have been derived by any process of sifting from a coast-sediment. It is believed by many that dry land lay in the West of England during the Chalk Period; but, even if this were so, what sort of land can it have been that yielded neither mud nor mineral fragments, both of which are almost entirely absent from the Taplow Chalk? Even the finer constituent of the rock consists either of minute organisms or of fine powder derived from the breaking up of the larger shells; and from whatever direction it was drifted, it must have been from a region almost unreached by mineral sediments.

In considering the effects of a current on these granules we should remember that phosphate of lime has a greater specific gravity than the carbonate, and that, consequently, there would be a tendency for the unaltered granules to separate themselves out from a partially phosphatised assemblage of microscopic organisms. In a current of suitable velocity the phosphatic granules would be naturally concentrated, much as they are artificially in the washing of the phosphatic chalk for the market. If we suppose some such natural washing as this to have taken place, we need not imagine the granules to have travelled far, and can understand the absence of far-transported mineral fragments. We could also explain the existence of the abundant little coprolites, which have been noticed in the Taplow Chalk, on the supposition that, whether from a set of the tides or other cause, there were banks or hollows in the bottom of the Chalk-sea that were especially frequented by small fishes, to whose efforts was due the phosphatisation of the organic deposits of those particular spots. What fishes these were, and why their actions are observable in the Upper Chalk only, we have not yet ascertained.

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A. STRAHAN.

VI.

The Sequence of Plutonic Rocks.

THE fact that the lavas and ashes ejected in any one district vary in composition in the course of geological time has attracted the attention of those geologists who have devoted themselves to the study of volcanic regions from very early times, and attempts have been made to explain this variation by hypotheses as to the distribution of igneous magmas beneath the superficial crust of the globe. The chemical researches of Bunsen on the volcanic rocks of Iceland in 1851, led him to the view that the variations in composition could be explained by assuming the separate existence of two magmas, to which he applied the terms normal-pyroxenic and normal-trachytic. Any igneous rock would, on this theory, have the composition of one or other of the original magmas, or else an intermediate composition due to an admixture of the two magmas in some definite proportion. The mixture theory of Bunsen is probably not correct as an explanation of the origin of igneous rocks, but that it expresses with a very fair approximation to truth the variations in composition of volcanic rocks belonging to the basalt-, andesite-, and liparite-families has been established by hosts of analyses.

The "theory of the two magmas" is, however, usually associated with the name of Durocher, who, in his celebrated "Essai de Pétrologie Comparée," endeavoured to explain volcanic phenomena, and especially the sequence of volcanic rocks, by reference to two universal magmas which were supposed to form concentric spheres beneath the solid crust, and to be kept apart by reason of their difference in density. The upper and lighter magma was supposed to be practically identical with Bunsen's normal-trachytic magma, and the lower and heavier with his normal-pyroxenic magma. At the time when the theory was proposed it was commonly believed that the earlier eruptions were always of a trachytic, and the later of a basaltic character. This Durocher explained by supposing that the erupted material was at first drawn from the upper or trachytic layer, and finally, after this had been locally exhausted, from the under or basaltic layer. He recognised, however, that there were many facts which the theory as above stated could not account for, and these he endeavoured to explain by "liquation," by the accession of sea-water, and by the alteration of the magmas in course

of geological time. He also supposed that in some cases eruptions might take place from local basins in the earth's crust, and not from the universal concentric zones.

The theory of the two magmas possesses, at present, little more than an antiquarian interest. It was a bold attempt to solve, with wholly insufficient data, the problem of the sequence of volcanic rocks. The principal interest for us lies in that part of the paper dealing with what the author terms "liquation." He says:—"The magmas which have produced the igneous rocks are comparable to fused masses of several metals which separate in cooling into different alloys, according to the circumstances of solidification." Here we have a clear and distinct recognition of the important fact that a homogeneous magma may, in the process of cooling, become differentiated, and so give rise to igneous rocks of varying composition. This is the mode of viewing the matter which is at present receiving a considerable amount of attention.

The attentive study of any crystalline igneous rock is sufficient to convince one that the consolidation of a molten magma is accompanied by differentiation. The original magma was homogeneous; the resulting rock is heterogeneous. As the molten mass cooled molecular groups of magnetite, augite, felspar, and the like were built up, became locally concentrated, and finally coalesced to form solid crystals. The whole rock did not consolidate at once. The minerals commenced to form at different stages. There was a sequence in this process of crystal building. If, after consolidation had progressed to a certain extent, the crystals had been filtered away from the mother liquor, the two portions thus obtained would have been found to differ widely in composition from each other and from the original magma. Suppose the original magma to have had the composition of an andesite or diorite, then the two portions would differ from each other as an acid rock differs from a basic rock. The crystalline aggregate would be poor in silica, rich in lime, iron and magnesia, and poor in alkalies, especially potash; the mother liquor would be rich in silica, poor in lime, iron and magnesia, and rich in alkalies, especially potash. That this is no mere speculation, but an actual fact, can be proved by observing the order in which the minerals form, or by separating the ground-mass from the porphyritic crystals in some typical andesite, and determining its composition by direct analysis. Thus, the ground-mass of one of the Cheviot andesites has been shown by Petersen to have the composition of a quartz-felsite or liparite.

Differentiation by crystal-building in magmas of intermediate composition may therefore give rise to secondary magmas of increasing acidity. Are there any facts which such a differentiation would explain?

Again, the phenomena of crystal-building seem to imply that differentiation must precede the actual formation of a crystal.

There is probably a local concentration of molecules before a crystal is actually produced. This leads us to consider whether magmas may not become differentiated quite apart from the actual separation of crystals.

It follows, as a necessary consequence of Van't Hoff's theorem (4) relating to osmotic pressure, that if the different parts of a dilute solution are at different temperatures, the degree of concentration will vary inversely as the absolute temperature. Thus, to take a numerical example, the amounts of salt in a given mass corresponding to temperatures of 80° and 20° C., after equilibrium has been established, will be as

$$(273+20):(273+80)=293:353=1:1\cdot205.$$

In other words, a given weight of the colder portion will contain about one-fifth more salt than the same weight of the warmer portion. This had been experimentally established by Soret before Van't Hoff proved it to be a consequence of a more general law, and it may therefore still be conveniently referred to as Soret's principle. Seeing that igneous magmas are of the nature of solutions in which the mineral on the point of separating out may be supposed to be dissolved in the rest of the magma, we have every reason to believe that Soret's principle may have important geological applications.

The general order in which constituents separate out in magmas of intermediate composition is as follows. First, iron-ores, then the ferro-magnesian constituents, and, lastly, felspars and quartz. Among the felspars, the lime-soda members of the group precede oligoclase, orthoclase, and microcline. From this we see that the compounds liable to be concentrated by Soret's principle are, first, those of the iron-ores, and, secondly, those of the ferro-magnesian silicates. Later on we shall call attention to certain facts which receive a simple interpretation by the application of this principle. At present, however, we have to notice another cause which tends to destroy the homogeneity of a solution. Gouy and Chapéron, by applying a well-established principle of thermo-dynamics, have deduced the conclusion that a solution standing at rest under the influence of gravity will become more concentrated in the lower than in the upper part. It is difficult to verify this conclusion experimentally, because the height of the liquid column must be very great—something like 100 metres—in order that any sensible differences may be produced. Another cause which may operate to intensify the concentration started in some other way is magnetic attraction; at least this is suggested by Professor Vogt (4), although it cannot be said to rest on evidence as satisfactory as that which can be advanced in support of the principle of Soret or that of Gouy and Chapéron. The idea is that the molecules of ferriferous compounds are themselves liable to be affected by magnetic attractions, so that if a local accumulation of such molecules be produced in any way, this attraction will intensify the concentration and extend the space in which it is going on.

With these general and more or less disconnected remarks, let us now consider some cases in which a definite sequence of igneous rocks has been established. That we are very far from being able to explain all the facts must, of course, be admitted at once, but at the same time we may be allowed to remark that there are not wanting indications that some of these facts are due to the operation of those causes to which attention has been drawn.

We commenced this article by referring to volcanic rocks. Now the magmas from which such rocks are derived must either exist independently in the interior of the earth, or else be formed by differentiation from some pre-existing magma, or in some other and unknown way. In any case, seeing that plutonic rocks originate in the earth's interior, and represent, so to speak, the subterranean manifestations of volcanic energy, it seems probable that a careful study of the relations of complex plutonic areas will throw light on the origin of different magmas. It is possible that some plutonic areas may represent consolidated magma-basins that have never been tapped. At any rate, if there be anything in the differentiation theory, it is in plutonic masses that we shall find evidence in its support. In what follows we shall therefore deal almost exclusively with plutonic phenomena.

The first area to which we shall refer is the one which has been so exhaustively studied by Professor Brögger (1). Between Lake Mjösen on the N.N.E. of Christiania and the Langesundfjord on the S.S.W. is a tract of country, about 230 kilometres in length and varying from 35 to 70 kilometres in breadth, composed of lower Palæozoic strata and post-Silurian eruptive rocks. This vast area of about 10,000 square kilometres is separated from the surrounding Archæan rocks by a series of important faults. Sometimes there is one main fault, with a throw of over 1,000 metres, at other times there is a group of smaller faults. In all cases the effect of the faulting has been to depress the rocks within the area above mentioned. This sunken district has been the site of important igneous phenomena, and more than half of it is now covered by igneous rocks, some of which were poured out at the surface, while others were intruded in the form of huge laccolites amongst the sedimentary strata. There is every reason to believe that the sinking of this portion of the earth's surface and the intrusion and extrusion of igneous material are correlated phenomena; and this district may therefore be quoted in support of the opinion so largely held by the Vienna-school of geologists, that volcanic action is especially characteristic of sinking areas. The fossil-bearing strata attain a thickness of from 700 to 850 metres, and they represent an unbroken succession of Cambrian, Ordovician, and Silurian rocks. A grey or red sandstone, without fossils, probably representing the Old Red Sandstone, overlies the fossiliferous rocks conformably, and attains a thickness of 380 metres. The total thickness of the

Palæozoic formations is thus over 1,000 metres. The oldest igneous rocks are interstratified with the uppermost members of the Palæozoic sequence, and, therefore, probably belong to the Old Red Sandstone period. They are basic rocks of the diabase family, containing from 45 to 47 per cent. of silica. The plutonic rocks of the same age and character occur as small but well-characterised laccolites at Sölvsberg and Brandbokampen on the east side of the Randsfjord. The rock of the former locality is an olivine-diabase of granitic structure (gabbro-diabase), composed of plagioclase, olivine, violet pyroxene, biotite, and iron ores; that of the latter a coarse-grained proterobase (gabbro-proterobase) containing a basic plagioclase, pyroxene, brown basaltic hornblende, and biotite, together with idiomorphic titanite, magnetite, and pyrite. An apophysis from the proterobase of Brandbokampen shows a marked porphyritic structure. The phenocrysts are formed of brown hornblende and pyroxene; the groundmass of lath-shaped plagioclase, prisms of brown hornblende, and iron ores. This rock is regarded by the author as a typical camptonite. The area occupied by intrusive basic rocks is, however, very small compared with that covered by the sheets. The rocks of these sheets are variable in character, and are grouped under the terms augite-porphyrite, melaphyre and labrador-porphyrite.

The plutonic rocks of the second group include basic augite-syenites (laurvikite), mica-syenites, and nepheline-syenites (laurdalite). They are especially developed in the south-western portion of the district, and form the coast-line between Tönsberg and Langesund. The augite-syenite is a coarse-grained rock with a peculiar structure due to the abundance of a felspar which occurs in large individuals, and shows a marked tendency to idiomorphism, with development of the forms $\{110\}$ and $\{\bar{2}01\}$. These forms give rhombic sections in almost all directions. The other constituents occur in smaller individuals, and are wedged in between the conspicuous felspars. The constituents are soda-orthoclase or soda-microcline (anorthoclase), violet (titaniferous) or green (alkali-bearing) pyroxene, biotite, brown hornblende, olivine (usually but not invariably present), titaniferous magnetite or ilmenite, apatite, nepheline, and sodalite (both common, but only present in small quantity). For this special type of augite-syenite, which is distinguished from other types by the character of the felspar and the presence of nepheline and sodalite as accessory constituents, Brögger proposes the name of laurvikite.

The mica-syenites are closely related to the above, but the felspar is mostly oligoclase, and gives rectangular instead of rhombic sections. Biotite, as the name implies, is abundant.

The nepheline-syenites have the same structure, and are composed of the same minerals as laurvikite, but nepheline (elæolite) occurs as an essential constituent, and sodalite is often present. The texture is very coarse, and the individuals of nepheline are sometimes

as large as one's fist. Secondary products, after nepheline (cancrinite, analcime, natrolite, &c.), are very common. For this special type of rock the author proposes the term laurdalite.

The contact-facies of the rocks of this group is represented by the well-known rhomben-porphyry, and the same rock forms sheets which overlie the augite-porphyrites. Boulders of this rock transported by the ice of the glacial period may be found on our own coast near Cromer. The silica of the plutonic members of the second group ranges from 51 to 58 per cent., and the alkalies from 9·5 or 10·5 per cent. in the laurvikites, to as much as 16 per cent. in the laurdalites.

The third group is composed of quartziferous augite-syenites. These rocks have a typical granitic structure, and the felspars no longer show the rhombic sections so characteristic of most of the rocks belonging to the second group. They differ from the laurvikites in containing plagioclase as well as orthoclase, and in the abundance of brown biotite ; also in the more pronounced idiomorphism of the green pyroxene, in the absence of nepheline, sodalite, and usually olivine, and in the almost constant presence of quartz. They occur in much smaller masses and have a much finer grain than the typical laurvikites. The author proposes the term akerite for rocks having the above characters. The silica ranges from 58 to 62·5 per cent.

The rocks which come next in point of time cover a large area between Christiania and Lake Mjösen. They are described by the author as red quartz-syenites, and the silica ranges from 60·45 to 66·39 per cent. The alkali percentage is still very high (12 to 13 per cent.), and the two alkalies are present in nearly equal proportions, soda, however, being slightly in excess. Felspar is by far the most important constituent. Orthoclase, oligoclase, and microcline are present. Microperthitic intergrowths of orthoclase and albite are common. The ferro-magnesian constituents include biotite, green pyroxene, ægirine, green hornblende, arfvedsonite, and sometimes glaucophane. Titanite, zircon, apatite, and iron-ores are accessory constituents. Quartz is always present, and in greater abundance than in the akerites. The structure is granitic; but a special feature is the occurrence of small angular drusy cavities, often lined with beautiful crystals of felspar, albite, quartz, ægirine, and titanite. The presence of the minerals ægirine, arfvedsonite, and glaucophane is evidently connected with the high percentage of soda. These rocks, like so many others from this remarkable district, are sufficiently peculiar to deserve a special name, and the author accordingly proposes to call them nordmarkites.

The rocks of the fifth group are termed soda-granites. They include hornblende-granite (rich in soda) arfvedsonite-granite, and ægirine-granite. The silica varies from 69 to 75 per cent. The dominant rock is a hornblende-granite rich in quartz. The horn-

blende is markedly idiomorphic, and often belongs to the arfvedsonite type. This type is frequently associated with a little glaucophane or ægirine. Biotite is much less developed in the rocks of this group than it is in those of the preceding and succeeding groups, and it is frequently absent altogether. The felspar is often microcline, with which albite is associated in microperthitic intergrowths. Oligoclase is also present. Quartz is always present in considerable abundance. The accessory minerals include titanite, zircon, orthite, magnetite, and pyrite. The structure is that of a medium-grained granite. The drusy or miarolitic cavities so common in nordmarkite are found also in the rocks of this group.

About half-way between Lake Mjösen and the Langesundfjord is an area of 700 square kilometres occupied by normal biotite-granite (granitite). In all the preceding rocks soda is in excess of potash, although in some cases the difference in amount of the two alkalies is only slight. In the rocks of this, the sixth group, the potash is in excess, and we have to deal with normal granites, such as are widely distributed over the earth's surface. The silica varies from 75 to 77 per cent. The constituents, mentioned in the order of their formation, are apatite, zircon, magnetite, titanite, biotite, felspar (orthoclase, microperthite, oligoclase), and quartz. Fluorspar and albite occur in drusy cavities; and epidote and chlorite are amongst the secondary products. This granite occurs in laccolitic masses, and is the latest rock of the first great series of eruptions.

The only igneous rocks which remain to be considered occur as thin vertical dykes. They are extremely abundant, and as a rule vary from a half to three metres in thickness, very rarely reaching ten metres. They are basic in composition, and are grouped by the author under the terms diabase, diabase-porphyrite, proterobase, and proterobase-porphyrite. Amygdaloidal structures are common.

Leaving these basic dykes out of account, we have in the first six groups a continuous series of eruptive rocks; that is, a series connected by intermediate forms. The oldest basic rocks pass into the laurvikites, and these into the laurdalites. Again, from the laurvikites we pass through the mica-syenites, akerites, nordmarkites, and soda-granites to the normal granitites. This petrographical sequence corresponds in the closest manner with the geological sequence; in other words with the order in which the rocks have been formed. The oldest rocks are the most basic, and the youngest rocks, excluding the dykes, are the most acid. Between the two extremes we have a continuous series. The volcanic series is not so complete as the plutonic, but so far as it goes the sequence is the same. The fact that most of the rocks are of a peculiar type clearly indicates that they must have originated in some enclosed magma-basin. It is quite impossible to explain their local character and the chronological sequence of the different types on the assumption that the rocks are the result of the consolidation of material derived from

any universal concentric zones. The distinguishing character of the local basin from which these rocks were derived was its extraordinary richness in soda. The author attributes the petrological sequence to the differentiation of an originally homogeneous magma, and refers especially to Soret's principle and to the effects of successive crystallisation as possible causes of this differentiation.

The facts above described may be roughly grouped together by the following hypothesis. A magma-basin existed beneath the Christiania district. During the Cambrian, Ordovician, Silurian, and part at least of the Devonian periods, a sea covered the area, and sedimentary deposits attaining a thickness of about 4,000 ft. were laid down. Then the first faulting commenced, and the district began to subside into the underlying magma-basin. Basic rocks were intruded and extruded. The faulting and subsidence were continued at intervals, and magmas of increasing acidity were successively squeezed out until the great granitic laccolites were formed. Then, finally, numerous cracks were formed, and basic material injected into them.

The phenomena seen along the south-west margin of the laurvikite district, that is, in the immediate neighbourhood of the great boundary faults of the Langesundfjord, have such an important bearing on the origin of certain structures in gneisses and schists that some reference to them seems desirable, although they do not bear on the subjects we are especially considering.

Along the north-eastern margin of the district in question, where the consolidation of the laurvikite-magma was not accompanied by movement, a massive rock, closely resembling the rhomben-porphyry of the sheets, was produced. Along the south-western margin the rhomben-porphyry type of rock is entirely absent. The contact phenomena are of a much more complicated character. The coarse-grained massive laurvikite is here intimately associated with a finer grained rock, which is usually striped or banded, and sometimes even schistose. For this rock, which is somewhat richer in nepheline and sodalite, and possesses a more uniformly granular structure than the laurvikite, the author proposes the general term ditroite.

In many places, and especially in the islands at the entrance of the Langesundfjord, the fine-grained banded ditroite and the coarse-grained laurvikite are blended in such a way as to suggest that they are merely "schliere" of slightly different composition. This, however, is not the case, for closer examination proves that the laurvikite was solid when the ditroite was intruded. The foliation of the ditroite is a kind of fluidal structure. Differential movement arranged the darker constituents in stripes parallel to the bounding surfaces, and fractured the larger constituents, especially the felspar and nepheline. Moreover, the angles of these constituents were often rounded off by the same movement, so that after final consolidation a rock with a typical primary augen-structure was

produced. The microscope confirms these conclusions, and shows that crystals have not only been rounded, but also reduced to the condition of fine detritus. It is clear, therefore, that when the ditroite was pressed upwards it consisted of a magma crowded with already formed crystals. The author proposes the term protoclastic for structures of the above kind, to distinguish them from the cataclastic structures of Professor Kjerulf, which are due to the deformation of a rock subsequent to final consolidation.

In the immediate neighbourhood of the junction the laurvikite has frequently been so broken up as to constitute a true breccia. Lenses of laurvikite measuring from a half to one metre across, sometimes smaller, however, and sometimes much larger, lie in a matrix of ditroite. This remarkable complex appears to have been formed in the following way. After the laurvikite had been consolidated it became broken up into large and small fragments by a renewal of the sinking process along the junction, and, at the same time, the ditroite-magma, with its already formed crystals, was intruded. The fragments of the laurvikite became rounded, and the ditroite-magma caught up the detritus of the rock into which it was injected. The fluidal structure in the ditroite is related to the lenticles of laurvikite exactly in the same way as the fluidal structure in a rhyolite is to the phenocrysts of felspar and quartz. If we use the term rhyolite in its etymological sense, we may speak of the complex rock here referred to as a rhyolitic breccia. There is no reason to believe that any important interval of time elapsed between the consolidation of the laurvikite and the intrusion of the ditroite; indeed, the occasional blending of the two rocks seems to imply that the laurvikite had sometimes scarcely solidified before the intrusion took place. The figures and descriptions of the author show clearly that the phenomena here referred to are exactly similar to those which may so often be seen in any extensive gneissose region.

In the same district pegmatitic injections may also be observed, and this still further increases the resemblance to gneissose areas. The author remarks that the phenomena above referred to can scarcely be described by the term structure, inasmuch as we are here dealing with the mutual relations of rock-masses and not with the mutual relations of minerals. He accordingly proposes that the term architecture should be employed instead.

The laurvikite, however, is not the only rock which occurs as inclusions along the south-west margin of the plutonic area. Lenticular masses of augite-porphyrite and rhomben-porphyry are also found. In one locality fragments of augite-porphyrite are surrounded partly by pegmatitic syenite and partly by a very dark variety of schistose ditroite, which is termed by the author ægirine-ditroite-schist. This basic ditroite forms a narrow zone, about half a metre broad, round the lenticles of augite-porphyrite, and, therefore, probably owes its basic character to the absorption of certain

constituents, especially iron-oxide and lime, from the included rock. The lenticles of rhomben-porphyry show very interesting structural features in their external portions. In the interior they are massive, and the large porphyritic felspars give the characteristic rhombic sections; near the margins they are foliated, and the porphyritic felspars have been deformed into long narrow lenticular folia. The structural modification is exactly similar to that which would be produced by dynamo-metamorphism of a regional character. Here it is associated with contact-metamorphism and is a purely local phenomenon.

We must now return to the consideration of the mutual relations of the rocks of plutonic masses. The general question of the differentiation of plutonic magmas has been discussed in a recent paper by another Scandinavian geologist, Professor Vogt (4). The immediate object of this paper is to explain the origin of certain ore-deposits, and especially those of the Ekersund district in Norway, and of Taberg in Sweden. The one in the former case is ilmenite, and in the latter titano-magnetite. In both cases the ores are intimately associated with basic eruptive rocks, in which the same minerals occur as accessory constituents; but the actual relations of the ore-deposits to the surrounding rocks are not the same in the two cases. At Taberg the ore occurs in the centre of a mass of olivine-hyperite into which it passes by insensible gradations. The ore itself contains a small quantity of olivine and felspar. As the rock is traced outwards, felspar increases in quantity, and pyroxene makes its appearance. Thus it passes into a hyperite rich in magnetite and olivine, and finally into normal olivine-hyperite. Such relations clearly imply that the ore-deposit has been formed by a local concentration of ferriferous molecules in a plutonic magma, or else by the local accumulation of magnetite grains or crystals after separation. The author inclines to the former hypothesis.

The Ekersund ilmenite deposits form dyke-like masses in a rock mainly composed of labradorite. The other rocks in the same eruptive district are hypersthene- and biotite-norites, and enstatite granite. The relative ages of the different plutonic masses have not yet been determined, but the ore-deposits appear to be distinctly later than the surrounding labradorite-rock, for they occasionally contain included fragments. Microscopic examination of the mutual relations of the individual constituents of the ore-deposit does not support the view that it has been formed by the mechanical accumulation of solid crystals or grains of ilmenite, and the author concludes that the concentration was produced in the magma without the actual separation of minerals. In other words, he supposes that a magma having the composition of the ore was produced by diffusion processes such as those referred to at the commencement of this article. As illustrating the nature of these diffusion processes, he refers to a remarkable dyke occurring near Huk in the Christiania

district. This dyke is ten metres thick. The centre is composed of porphyritic crystals of orthoclase, and a fine-grained matrix of biotite, orthoclase, plagioclase and quartz. Pyrite, magnetite and apatite occur as accessory constituents. As the border is approached, magnetite, pyrite and biotite increase, plagioclase takes the place of orthoclase, and the rock becomes finer in grain and darker in colour. Quartz is entirely absent from the marginal rock. The rock of the centre contains 61·71 per cent. of silica, and is a porphyritic mica-syenite; that of the margin contains 43·33 per cent. of silica, and is a basic kersantite. A narrow vein runs off from the main dyke at one point. The rock of this vein becomes more and more basic as it is traced away from the junction, and at the termination contains 15 per cent. of magnetite. There is no evidence whatever of successive eruptions in this dyke. The transition from the acid to the basic rock is perfectly gradual. The minerals are concentrated in the order of their formation, and the phenomena are, therefore, capable of explanation by Soret's principle. Seeing that the basic portions of the dyke are vertical, that is, parallel with dyke-walls, it is impossible to explain the differentiation by the local accumulation of the first-formed crystals. Magmatic differentiation appears to be necessitated by the facts of the case.

Somewhat similar phenomena have been observed by Professor Lawson (3) in the basic dykes of the Rainy Lake region of Canada. The differences are not so strongly pronounced, but they are of the same general character. Thus, in five dykes, the percentage of silica in the rock from the centre was found to be in excess of that in the rock from the margin. In the White-fish Bay dyke the marginal rock contained 47·5 per cent., and the rock from the centre 52·47 per cent. Along with the increase in silica there is a decrease in lime, iron, and magnesia, and an increase in alkalies. The texture of the marginal rock is trachytic, that of the intermediate rock ophitic, and that of the centre granitoid.

Mr. Iddings has described a set of related plutonic and volcanic rocks (2) occurring in the Yellowstone National Park. The sequence in both cases is the same, and the latest rocks are the most acid. Thus, referring only to the intrusive rocks, occurring as dykes and stocks, pyroxene-porphyrites with a holocrystalline ground-mass pass into, and are succeeded by, pyroxene- and hornblende-diorites, these, again, by hornblende-biotite-diorites, and these by porphyritic quartz-biotite-diorites. As the author remarks, the whole series is a single, irregularly interrupted succession of outbursts of magma that gradually changed its composition and character. Eleven analyses are given, showing a gradual increase in silica from 56·28 per cent. to 69·24 per cent.

The writer of the present article, in conjunction with Mr. Dakyns, has recently described an area of plutonic rocks occurring near the head of Loch Lomond (5). The oldest rocks of the complex are

peridotites, and the newest are eurites, composed almost entirely of quartz and orthoclase. Between these two extremes occur augite-diorites, diorites, quartz-diorites, and biotite-granites. The silica ranges from 38·6 per cent. to 75·8 per cent. It seems impossible to avoid the conclusion that this complex owes its origin to the differentiation of an originally homogeneous magma and that the cause of the differentiation is to be sought for in the order in which the minerals successively form in igneous magmas.

So far we have been mainly concerned with large areas of plutonic rock; but intrusive masses of no great size often show a want of uniformity in composition such as can only be accounted for by differentiation before or during consolidation. As illustrations we may mention the felsitic and granophyric patches and veins in the Carboniferous dolerites of Scotland, as, for example, those in the neighbourhood of Stirling, and the corresponding phenomena in many mica-traps. A rude kind of cellular structure may often be observed in the latter rocks, the cell-contents being richer in ferro-magnesian constituents than the cell-walls.

We see, therefore, in this, as in so many other branches of geology, that illustrations of the principles which enable us to explain the structure of large areas may be observed in hand specimens or even microscopic slides. If the differentiation theory be correct, the micro-pegmatitic interstitial matter in an augite-diorite has originated in the same way as the mountain-making granophyres of the Inner Hebrides. The facts to which reference has been made appear to show that a more or less gradual sequence from basic to acid rocks is of very frequent occurrence, and that such a sequence can be correlated with the order in which minerals are known to form in igneous magmas.

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J. J. H. Teall.

VII.

The Grammar of Science.

ON first glancing at the pages of Professor Karl Pearson's new book[1] the biologist might be tempted to suppose that, apart from the chapter on Life, there was little therein with any bearing on his special studies. He might be inclined to regard it as a mixture of physics and metaphysics. And such, indeed, it is in part. I am not using the word metaphysics as a term of reproach. By metaphysics I mean a discussion of the ultimate nature of the phenomenal world and of the conscious Ego. Physics as such accepts the phenomenal world as external to, and for its purposes independent of, the mind of the investigator. It leaves to psychology the analysis of the human mind, and to metaphysics the perhaps insoluble question of the ultimate nature of the Ego and of the external occasion of its perceptions. Professor Pearson does not enter into the metaphysics of the Ego. He is content naïvely to accept the investigating mind as he finds it. But he is not content to accept with equal *naïveté* the phenomenal world; he enquires what it really is, and how we come to perceive it and to reason about it. He is forced to a position which is largely idealistic. The physical world is in a sense the product of the percipient mind, and Mr. Pearson contends that this is a fact which we must not only not lose sight of, but must introduce into all our physical considerations. But biology and geology are sciences which investigate peculiarly complex and intricate manifestations in the physical and phenomenal world; and what Mr. Pearson says of physics therefore applies in large degree to these sciences also. I propose, therefore, to endeavour to explain Mr. Pearson's position, and to offer some criticisms thereon.

In an introductory chapter Mr. Pearson vindicates the right of Science to claim the whole sphere of the knowable as its province. Over this we need not linger. That which follows, however, on The Facts of Science, demands our closer attention.

Here it is pointed out that, in the perception of a so-called "external object," all we are justified in predicating is that we experience certain sense-impressions which suggest the given percept. Thus, a retinal impression may suggest the percept "book," to the making of which there goes a good deal more than the simple

[1] The Grammar of Science. By Karl Pearson, M.A., Sir Thomas Gresham's Professor of Geometry. *Contemporary Science Series.* London: Walter Scott, 1892.

sense-impression. Since, therefore, the percept contains elements not given in the immediate sense-impression, but contributed from the stored sense-impresses of the percipient mind, we may say that it is, in part at least, and often to a large extent, *constructed* by the percipient in the moment of perception. The polished Ammonite which I use as a letter-weight is a percept suggested by certain retinal sense-impressions. As an object, it is resisting to the touch, heavy, and so forth. I can readily verify the reality of the object in these respects through the appropriate channels of tactual and muscular sense-impression. It is, moreover, a reality not only for me, but for any normal human being who may chance to be by my side. As a "construct" it is not only individual, but social: a perceptual product not only of me, but of man. Such, in brief, are the conclusions which result from the psychological analysis of the process of perception, and which are accepted and endorsed by Mr. Pearson. Here psychology as a science is content to leave the matter. But if we go further and enquire whether there is an external "reality" which is the occasion of my percept and that of my neighbour, we enter upon a metaphysical problem. We must note that the word "reality" is here used in a sense different from that in which I used the word *real* above. There I meant by *real* common to me, you, and all normally constituted human beings. Here by "reality" is meant an existence independent of human perception.

Let us hear what Mr. Pearson says with regard to this "reality." "Turn the problem round, and ponder over it as we may," he says, "beyond the sense-impressions . . . we cannot get. Of what is beyond them, of 'things-in-themselves' . . . we can know but one characteristic, and this we can only describe as a capacity for producing sense-impressions . . . This is the sole scientific statement which can be made with regard to what lies beyond sense-impression." Even this he qualifies, if he does not nullify, a little later, when he says: "There is no necessity, not even logic, in the statement that behind sense-impressions there are 'things-in-themselves' *producing* sense-impressions." If I understand him rightly, Mr. Pearson's view is that the very utmost we can predicate concerning the occasion of sense-impressions is its existence; of its "real" nature we can assert nothing, not even its externality to the percipient. Presumably, however, he would not deny that there is something about it which we *symbolise* as externality or outness from ourselves as percipients.

Before leaving this question of perception, or the "construction" of external objects, there is one further remark I have to offer. We may agree with the result of the analysis, and yet we may hold that its constant obtrusion in the consideration of the phenomena of what *for perception* is the external world, is likely to lead rather to the confusion of than to the simplification of our scientific treatment. These conceptual results of the analysis of the perceptual process are on a

different plane of investigation from that which deals with the phenomena themselves. And the introduction of results obtained on one plane of investigation among the results obtained on other planes is apt to be confusing, if not misleading.

We pass now from the object to the "eject." To some of our readers the term "eject" may be unfamiliar. Suppose that my neighbour and I are both looking at some object, say my Ammonite letter-weight. I have a percept; and I have every reason to suppose that he too has a similar percept. But his percept can never be an object to me; nor my percept an object to him. His states of consciousness are for me, as mine are for him, in Clifford's phrase "ejects." Clifford himself puts it shortly thus: "When I come to the conclusion that *you* are conscious, and that there are objects in your consciousness similar to those in mine, I am not inferring any actual or possible feelings of my own, but *your* feelings, which are not, and cannot by any possibility become, objects in my consciousness." This, of course, was no new discovery of Clifford's, but he coined the convenient word "eject," by which each of us may denote our neighbour's consciousness. Whether we use Clifford's word or not matters comparatively little; but few deny the fact which suggested to him the necessity for such a word, namely, that my neighbour's consciousness can never be to me an object of perception or produce in me a direct sense-impression. That is reserved for Professor Pearson. "To this [the statement I have quoted from Clifford] it may be replied," he says, "that were our physiological knowledge and surgical manipulation sufficiently complete, it is conceivable that it would be possible for me to be conscious of your feelings, to recognise your consciousness as a direct sense-impression; let us say, for example, by connecting the *cortex* of your brain with that of mine through a suitable commissure of nerve-substance." Mr. Pearson refutes himself, however, on the very next page, when he says: "Psychical effects are, without doubt, excited by physical action, and our only assumption is the not unreasonable one that a suitable physical link might transfer an appreciation of psychical activity from one psychical centre to another." In other words, the recognition of one's neighbour's consciousness, in the supposed case, is not direct but through the intervention of a physical nexus. But there is no difference in principle between the excitation of the sensorium through such a supposed *physical link* and the excitation of the sensorium through the known physical links involved in oral communication. No one questions that the molecular vibrations of one brain may, through physical links, give rise to similar molecular vibrations in another brain, and that the consciousness which accompanies the one may run parallel with the consciousness which accompanies the other. But this is something wholly different from my recognising your consciousness "as a direct sense-impression."

In the next chapter, on The Scientific Law, a distinction is drawn, first, between the laws of nature and civil laws, and, secondly, between *natural law*, descriptive of the normal order of sequence in perception, and *scientific law*, the product of our conceptual thought as exercised on the materials given through the normal routine of perception. This latter distinction answers fairly well to that between what Mr. Herbert Spencer calls the laws of phenomena and the laws of the factors of phenomena. The former are general but concrete; the latter general and abstract. We must, however, pass over this chapter and that which follows (on Cause and Effect, and Probability) without further comment, though we could break a lance with Mr. Pearson on the grounds of his statement that "among the myriad planetary systems we see on a clear night, there surely must be myriad planets which have reached our own stage of development, and teem, or have teemed, with human life." It may be so. But seeing how enormously complex are the influences which have conspired to bring about man as the crowning product of evolution on this earth, we should judge it to be indefinitely improbable that human beings, as such, have been evolved on any one of these myriad planets.

The succeeding chapter on Space and Time is an important one. Space is described as the mode in which we perceive co-existing things apart, while time is the mode in which we perceive successive things apart. Mr. Pearson illustrates this Kantian contention by an analogy. The letters of the alphabet may be said to have a real existence, like the groups of sense-impressions we term objects; but the *order* of the letters is merely the mode in which we perceive them to co-exist as an alphabet. Space, in like manner, is an order or mode of perceiving objects; but it has no more existence if objects are withdrawn than the alphabet would have if there were no letters. So, too, with time. "Let the reader endeavour to realise empty time, or time with no sequence of events, and he will soon be ready to grant that time is a mode of his own perception, and is limited by the contents of his experience." Now, it may at once be granted that, in the absence of the sense-impressions which, for example, now suggest to me the percept which I call my clock, I could not recognise it as an object extended and distant; and that in the absence of the ticking sounds I could not recognise them as successive. But surely that is not the question. The question is whether, given certain sense-impressions which suggest the percept clock, there are any objective relationships which I can describe by using the adjectives distant, extended, and successive. I am prepared to maintain that the relationships which I thus describe are just as objective as are the sense-impressions themselves. Neither they nor the sense-impressions have any existence, *as such*, in the absence of the percipient mind. But whatever objective existence may be predicated of the sense-impressions, may be predicated also of their

spatial and temporal relationships. I know no more than Professor Pearson does of the nature of things-in-themselves, or ding-an-siches, or suchlike; but I do, as man, know somewhat of the world of phenomena, which is, for perception, external to me, and has extension, and in which my clock is ticking in rhythmic sequence; and I maintain that, *for perception*, the relationships of these objects are just as much external to me (and just as *little*, be it noted, in conceptual analysis) as are the objects themselves. I venture to think, therefore, that to regard space and time as "modes of perception" is, to say the least of it, inconvenient when we are dealing with the field of practical perception. Physics, as a science, is wise, I take it, in dealing with space and time in frankly objective terms, and I think the biologist may still discuss the distribution of organisms in space, and the geologist their distribution in time, without pausing to remind their readers that after all they are only dealing with sense-impressions, and stored sense-impressions, and certain forms of perception. All this may be true enough, but it is out of place either in physics or biology.

I may here devote a short paragraph to the antinomy, or seeming contradiction, to which we are introduced in this chapter through a consideration of geometrical boundaries and the atomic constitution of matter. In geometry a plane surface is regarded as absolutely continuous: in molecular physics as composed of discontinuous molecules. These views seem to clash. "The conception atom, when applied to our perceptions, is opposed to the conception of surface as the continuous boundary of a body. We have here," says Mr. Pearson, "an important example of what is not an uncommon occurrence in science, namely, two conceptions which cannot both correspond to realities in the perceptual world. Either perceptual bodies have continuous boundaries, and the atomic theory has no perceptual validity; or, conversely, bodies have an atomic structure, and geometrical surfaces are perceptually impossible. At first sight this result might appear to the reader to involve a contradiction between geometry and physics; it might seem that either physical or geometrical conceptions must be false. But the whole difficulty really lies in the habit we have formed of considering bodies as objective realities, unconditioned by our perceptive faculty." I should myself explain the apparent difficulty in a somewhat different way. Scientific conceptions are general and abstract, and are reached, as Mr. Pearson well points out, by idealising beyond the limits of perceptual experience. Each investigator neglects, or intentionally excludes, such elements of perceptual experience as are disturbing or unnecessary for his special enquiry. He then idealises, or conceives in absolute perfection—a perfection far beyond the limits of experimental verification—the results he obtains. If these different investigators carry this process along different lines, each excluding the element the other is idealising, the results will not

only be divergent from each other, but divergent from the perceptual experience from which each started. This *divergent abstraction*, as we may term it, may be illustrated by an analogy. Two investigators study the same substance, say carbon disulphide, a dense, colourless liquid. One abstracts the sulphur and formulates its properties, neglecting the carbon: the other neglects the sulphur and investigates the carbon, formulating its properties. The resulting properties in the two cases are different, or even contradictory. One obtains a yellow solid with these properties; the other a black solid with those properties; and the phenomenal substance with which each started is neither the one nor the other, but a colourless liquid! So the geometrician obtains a geometrical conception of continuous surface, neglecting atomic structure: and the physicist obtains a molecular conception of discrete particles. But the perceptual conception, *as such*, has neither a continuous boundary *as idealised in geometry*, nor a molecular constitution *as idealised in physics*. And to predicate these idealised conceptions of "perceptual bodies," therefore, leads to antinomy and confusion; the moral of which is that we must not introduce among the concepts of one line of investigation the concepts which result from another line of investigation.

The next chapter, on The Geometry of Motion, starts by describing motion as "the *mixed* mode under which all perception takes place." This way of regarding the problems of motion is the natural outcome of the conception of space and time as modes of perception. How far the discussion of the geometry of motion in this chapter, and of Matter and the Laws of Motion in succeeding chapters, will be satisfactory to specialists in physics, it is not for me to say. Regarding the matter merely from the general standpoint of natural science, I must confess that it appears to me more simple, and more scientifically accurate, to regard matter and motion as frankly objective and (perceptually) external. This is, however, not Professor Pearson's view. "If we confine ourselves," he says, "to the field of logical inference, we see in the phenomenal universe not matter in motion, but sense-impressions and changes of sense-impressions, co-existence and sequence, correlation and routine." Now although direct perception does not give us abstract matter in ideal motion, it does most certainly give us particular moving things, animals and men going from place to place, unsupported bodies falling towards the earth, the balloon ascending through the air, the clouds drifting across the face of the moon. All these are for adult perception occurrences in the external phenomenal world. If the psychologist, as the result of his analytic thought, reaches the conception of "sense-impressions and changes of sense-impressions," well and good; but this does not alter one whit the fact that for perception the movements we observe are occurrences in the world of phenomena. It is perfectly true that the sense-impression is that which starts the perceptual process and calls the percept into being. But it is equally true that the sense-

impression is not given, as such, in the percept but is only disclosed by psychological analysis. The sense-impression is that which remains when we have stripped from the percept all that gives it perceptual validity. If the phenomenal universe, therefore, is the world of perception, I am disposed to reverse Professor Pearson's statement, and to say that "we see in the phenomenal universe not sense-impressions and changes of sense-impressions but objective bodies in objective motion."

In a word, the mistake which Mr. Pearson appears to me to make is that he attempts to combine the abstract results of psychological analysis with the abstract results of physical analysis. And since the results of these two modes of enquiry are reached by what I indicated above as divergent abstraction, they do not readily coalesce. The better plan is, I think, to keep the results separate, just as the geometrician and the molecular physicist keep separate their conception of continuous surface on the one hand, and discrete particles on the other.

Passing to the chapter on Life, we find that Mr. Pearson wisely abandons the attempt to give a brief definition of the distinction between living and lifeless, holding that consciousness and the phenomena of the will give us little or no assistance in the matter. "The distinction between the inorganic and the organic," he says, "cannot be defined by saying that the one is mechanical and the other is not. We are ultimately obliged, in order to define life, to take secondary characteristics—to describe the structure by which we conceptualise the organic corpuscle, the motions which are peculiar to it, and the environment in which alone we perceive life to exist." Some of these characteristics are then enumerated. They suffice, it is held, to mark off the organic from the inorganic, "and the distinction thus drawn appears to be absolutely rigid. There is, at the present time, so far as we know, no generation of living from lifeless substance." By saying, however, that the distinction is absolutely rigid, and that there is no generation of living from lifeless substance, Mr. Pearson does not mean to exclude the passage of the non-living into the living at some period of evolution. Nay, further, he expressly adopts this view. He indicates the three possible hypotheses with regard to the origin of life on this earth; first, that life might have arisen from the operation of some ultra-scientific cause (special creation); secondly, that its germs might have been introduced in the crevice of a meteorite; thirdly, that living matter might have been generated by a special union of inorganic corpuscles under a suitable environment (spontaneous generation), and he adopts that hypothesis which we have placed last.

With respect to the origin of consciousness, Mr. Pearson is not very explicit; but he somewhat scornfully rejects the view, held in some form by several thinkers, and recently urged by the present

writer,[2] that the consciousness that we know has been developed from something which is of the same nature as consciousness, but which has not yet risen to the level of consciousness. This infra-consciousness I hold to be associated with all forms of energy. Only when the manifestations of energy reach the complexity of the molecular vibration in nerve-centres does the infra-consciousness rise to the level of consciousness. Mr. Pearson suggests that we might as well say that there is in matter "something-which-is-not-yet-life-but-which-may-develop-into-life" and call it *supermateriality*. He has, however, I venture to think, missed the point of my contention. He objects that there is no sense-impression of such infra-consciousness. Of course not. I hold with most philosophers that consciousness is something of a wholly different kind from the energy through which we receive sense-impressions. If Professor Pearson holds that some mode of material existence or of energy has been developed into consciousness, let him adduce some satisfactory, or at least plausible, grounds for this belief. If not, let him tell us from what it has developed. Either consciousness has been reached by a process of mental evolution, or it has been specially created. Mr. Pearson will not, I take it, adopt the latter alternative. But if he accepts the former, I would ask him to inform us from what it has been developed. I venture to think that the conception of infra-consciousness co-extensive with energy is arrived at by the application of principles laid down by Mr. Pearson himself, namely, the carrying to a conceptual limit of that which is suggested in the sphere of the perceptual and ejective world. In any case, the analogy with life is beside the mark; for I hold with Professor Pearson that the distinction between the inorganic and the organic cannot be defined by saying that the one is mechanical and the other is not. From the inorganic to the organic we can conceivably pass by successive advances in complexity of structure and of associated modes of energy; but by no such advances can we conceivably reach consciousness, if, as I hold, consciousness is not mechanical, and is neither a mode of matter nor of energy. From what, then, has consciousness been evolved, if not from infra-consciousness associated with lower modes of energy?

In conclusion (for we must pass over the last chapter, on The Classification of the Sciences, without comment) I may say that the problems discussed with great ability and lucidity, and often in a most suggestive manner, by Professor Pearson, are such as should interest *all* students of natural science. Modern biology and geology are full of physical problems, and the students of these sciences must have some acquaintance with such physical conceptions as Mr. Pearson discusses. They should also have some acquaintance with the wider problems of the general philosophy of science. The central

[2] *Animal Life and Intelligence*, p. 467, and more recently in the *Monist* for January, 1892.

question raised by the *Grammar of Science* seems to be this: Are we, in biology, geology, and physical science, to abandon the frankly objective mode of regarding the phenomena we have to study, and to frame our descriptions and definitions in accordance with the idealistic results of psychology and philosophy? Fully impressed as I am with the general truth and value of these idealistic results in their proper place, I hold that their introduction into the objective study of nature is misleading, and tends to confusion. I advocate, therefore, the retention of what I have termed the frankly objective attitude, which is the attitude now assumed by students of natural science, and which even the eloquence and clear logical treatment (and it is both eloquent and logical) of the *Grammar of Science* will, I believe, fail to reverse.

C. LLOYD MORGAN.

SOME NEW BOOKS.

Island Life: or the Phenomena and Causes of Insular Faunas and Floras, including a Revision and attempted Solution of the Problem of Geological Climates. By Alfred Russel Wallace. 2nd edition. 8vo. Pp. 563. London: Macmillan and Co., 1892. Price 6s.

We can now congratulate our readers on the appearance of a second edition of this well-known book. It is, of course, difficult to criticise a volume by such a master of the subject as Mr. Wallace; but, notwithstanding this, we feel that it is due to naturalists, who will hope for a third edition, to point out in what respects "Island Life" might possibly be improved. For the general plan and execution of the book we have nothing but praise, and we must thank the publishers for the reduction of the volume to a more handy size than that adopted for the first edition. Those who often use a book of reference such as this, are well aware that weight is a serious consideration, and that it is an undoubted advantage to have the same material in a smaller compass, especially when there is no loss of legibility through the reduction.

In the new edition of his work, Mr. Wallace has most carefully revised the accounts of the natural history of the various islands described, for eleven years have added considerably to our knowledge of insular faunas. Turning first to Chapter XVI. (the British Isles), as referring to a district especially interesting to home-staying naturalists, we cannot help feeling that Mr. Wallace, with his extensive experience of tropical islands and their wonderful endemic faunas, is, perhaps, a little inclined to over-estimate the evidence in favour of the existence of various endemic species in Britain. No doubt we have a few such; but that fifteen species of freshwater fishes are peculiar to our islands we should be inclined to question, especially when we remember the remarks made by Dr. Francis Day on many of these so-called species. The passage (pp. 341–344) relating to the various forms of *Salmo* and *Corregonus* remains as it stood in the first edition, but some reference should have been made to Dr. Day's opinion. Nowhere, however, except in the present volume, can we find a list of all the animals and plants peculiar to Britain, and this alone would make it a useful book of reference, whatever may be our opinion as to the validity of certain of the species.

The large additions which have recently been made to our knowledge of the fauna of Borneo, Japan, Madagascar, the Galapagos, and the Sandwich Islands, are all embodied in the present edition. We should like, however, to have seen a fuller account of the Malay Archipelago, and of various islands in temperate and arctic seas, even if to introduce these, without increasing the bulk of the book, it had been necessary to omit the chapters on Glacial Epochs. Chapters VII. to X. seem to us to be the least valuable parts of the book, and we cannot help feeling that the author's position is often considerably weakened by his excursions into the

very speculative subject of the astronomical causes of changes of climate. No doubt we have abundant evidence of one "Glacial Epoch," apparently with a mild interval, and, so far, the naturalist is entitled to speculate on the influence of climatic changes on the migration of animals and plants. But when he hears of alternating cold and warm periods, extending throughout geological time, the geologist feels that the facts, as far as he has yet been able to ascertain them, do not yield clear evidence of any cold period older than that of Pleistocene date. When a book on "Island Life" contains a section on the "State of the Planet Mars as bearing on the Theory of Excentricity as a Cause of Glacial Epochs," one cannot help feeling that the author is perhaps wandering a little from the subject.

One other request we should like to make to Mr. Wallace, in view of a third edition. Much has lately been learnt as to the means by which animals and plants are transported across the sea, and valuable accounts have been published of the re-establishment of life on Krakatoa after total extermination by a volcanic eruption. Such observations are most important for the right understanding of insular faunas and floras. Could not the author devote a little more space to these subjects, so as to make his book a complete manual for students of Island Life? C. R.

KALM'S ACCOUNT OF HIS VISIT TO ENGLAND ON HIS WAY TO AMERICA IN 1748. Translated by Joseph Lucas. 8vo. Pp. xvi., 480. London: Macmillan and Co., 1892. Price 12s. net.

THE Naturalist may sometimes rejoice with the Historian in accounts of journeys made in this country before the present century. Thus the "Travels in England, Scotland, and the Hebrides," of Faujas Saint-Fond (translated and published in 1799), contain many interesting notes on the minerals and rocks of the districts visited, the author being Professor of Geology in the Museum of Natural History at Paris.

Pehr Kalm, the account of whose visit is now before us, was born in Sweden in 1716; he became a pupil of Linnæus, and subsequently assisted his master with contributions to the *Flora Suecica*. After travelling over much of eastern Europe, Kalm was, in 1747, nominated as the first Professor of Œconomy at Abo, and in the same year he was commissioned by the Swedish Government (aided by the Universities) to visit North America. He was instructed to observe and describe the natural productions of that country, the special object being the introduction into Sweden of useful plants. He arrived in England in February, 1748, but for want of a vessel to cross to America, he was obliged to wait in this country until the 5th August. To this delay we owe his notes on England, which have been happily translated from the Swedish by Mr. Lucas. Kalm's original work occupied three volumes, which are now very scarce, but the American portion was rendered into English in the last century.

While delayed in this country, Kalm made observations from four centres—London, Woodford, Little Gaddesden in Hertfordshire, and Gravesend. His notes are of a very miscellaneous character. They relate largely to agriculture, but also include many notes of the strata, especially of the Chalk and Totternhoe Stone, and of the Tertiary gravels and clays. He records sections in considerable

detail,[1] and notes the fossils, observing in one case, "This was an unfailing sign that the chalk-formation had in former times been sea, as well as that the chalk is a child of later times, unless these so-called mussel-shells are *lusus naturæ*." He observes, in particular, a coarse sand near Ivinghoe "which was not such as our most common sand in Sweden, viz., of quartz, but it consisted of bare flint, such as is found everywhere about here, which had been reduced to a coarser or finer sand."

It is interesting to learn that in the suburbs of London the fences around meadows and market gardens were frequently made of banks of earth interstratified with "a multitude of the quicks or inner parts of Ox-horns," often with part of the skull attached. There were sometimes as many as six layers of these fragmentary horns. The fact is of importance in connection with the abundant bovine remains that are sometimes dug up in the district mentioned; and we hear that in one instance Kalm's remarks have quite recently explained what might have been regarded as a curious geological discovery.

There are many notes on the trees and hedgerows, and on various plants met with. Kalm states that one day "we amused ourselves by seeking out and describing the plants which occurred in a haystack at *Hudnall*." He gives a list of 28 species, but of some only single examples were found. The translator tells us that the verification of the names of the plants would have been a hopeless task, but for the existence in the British Museum of two volumes of Kalm's work with MS. notes, from the library of Sir Joseph Banks.

The date of Kalm's visit was five years prior to the foundation of the British Museum. The collection of Sir Hans Sloane formed the first portion of the Natural History objects that were then brought together. Kalm records his introduction to Sir Hans, then reported to be in his 94th year, and to his collections "in all three Natural Kingdoms, *Antiquities*, *Anatomy*, and many *Curiosities*." Some account is also given of the "Chelsea Physick Garden," and Kalm notes that in a room up in the Orangery there was preserved as a great rarity the collection of plants formed by John Ray. This collection had been given by Ray to Samuel Dale, who presented it to the Physick Garden: but it is remarked: "In some places the plants had been cut out, for *Dr. Sherard* had borrowed this collection from Mr. Dale, and when he had found any plant, which was either rare, or he thought much of, it was said that he had either clipped or cut it out, so that the books had been sufficiently mutilated." Ray's herbarium is now in the British Museum.

The value of this work is of course to a large extent antiquarian, but, as we have noted, there are many facts that will interest both Geologists and Botanists. Furthermore, there is a good General index and a separate Botanical index.

H. B. W.

THE *Zoological Record* for 1890 was issued in March by the Zoological Society. The volume is arranged as usual, and edited by Mr. F. E. Beddard, who now retires from the work. The next volume, in progress, is under the editorial direction of Dr. D. Sharp, F.R.S.

[1] Records of two sections, communicated by Mr. Lucas, were published in Mr. Whitaker's "Geology of London," vol. i., 1889, pp. 174, 175.

THE APODIDÆ; a Morphological Study. By H. M. Bernard. 8vo. Pp. 316. London: Macmillan & Co., 1892. Price 7s. 6d.

WE cannot altogether congratulate the publishers upon the latest volume of the "Nature Series." The writer has set himself the "ambitious task" of proving that *Apus* and its immediate allies can be derived from a "bent carnivorous Annelid." It is the general opinion of naturalists that these Crustaceans stand nearer to the base of the Crustacean series than any other forms. There is, therefore, nothing particularly new in Mr. Bernard's contention; nor is there much evidence in the work before us added to what is already known concerning this possible origin of the Phyllopod Crustaceans. An ideally intermediate form between the Annelids and the Crustaceans should show that essential Annelid feature—a metamerism of the internal organs; and *Apus* is in this respect not in the least more worm-like than other Crustaceans. It is true that Mr. Bernard cannot be blamed for this; but he attempts to show that *Apus* does show traces of this internal metamerism in the sexual organs. The gonads are figured as being of an elongated form, with crenations along the margin; but it is putting too great a strain upon this comparatively unimportant fact to adduce it as evidence of a fusion between a series of segmentally repeated gonads. Zaddach described the gonads of this animal as forming a kind of network, while Mr. Bernard did not observe this, though believing, nevertheless, that it may exist; and this fact, if definitely proved, would be unquestionably of interest, for Dr. Benham, in an important paper upon the testis of the King Crab (*Limulus*), particularly dwelt upon the similarity which the retiform condition of that organ in *Limulus* shows to the Arachnids. As Mr. Bernard believes that *Apus* and *Limulus* are not far apart, it is surprising that he has not seized upon this point.

The principal new facts in the book concern the "water sacs" and the "neck gland." The former are paired sacs that spread out over the eyes, and appear to contain a watery fluid during life. Mr. Bernard thinks that they are an indication of the backward movement of the eyes. They represent, he believes, the soft non-calcified integument which lies between the dorsal sclerites. As the author is so eager to show affinities between *Apus* and worms, he might have made use of these structures as an argument by pointing out their possible identity with the ciliated tubes of the Gephyreans and of other Annelids which are related to the central nervous system. The neck-gland is considered by Mr. Bernard to be an excretory organ; and it is quite possible that he is right, though here again he has omitted to cite what might have been of use in assisting him to prove one of his views.

A special chapter of the book is devoted to a consideration of the resemblances shown by *Apus* to the extinct Trilobites. In many Trilobites, at any rate, there is a pair of pores upon the head-shield, which are very possibly comparable to these organs in *Apus*. Dr. Henry Woodward has lately, in the Palæontographical Society's memoir on the Carboniferous Trilobites, particularly emphasised the existence of these pores as evidence of a likeness between the Trilobites and certain Isopod Crustaceans, especially *Serolis*, where they also exist. There is probably something of interest here, though at present details are wanting.

The alleged hermaphrodite condition of *Apus* is the last remaining matter of special interest in the volume; and we do not think that

this hermaphroditism is as yet definitely proved. The figures given by the author are exceedingly poor; so too, it may be remarked, are many of the illustrations in the book. It is, in short, not possible to accept, without further proof, the statement that *Apus* is really hermaphrodite; but, considering that Dr. Bullar's discovery of the hermaphroditism of the Cymohoidæ was received with so much suspicion, though ultimately proved to be perfectly correct, it would be rash to commit oneself.

English Botany, or Coloured Figures of British Plants.—Supplement to the Third Edition. Part I. (Orders I.–XXII.) Compiled and illustrated by N. E. Brown. 4to. Pp. 56 and viii., with six plates. London: George Bell and Sons, 1892. Price 5s.

This, the first portion of a Supplement to English Botany, has been in preparation for several years. Two similar parts, we are told, are now nearly ready for publication, Mr. Brown having carried it as far as the Dipsaceæ, but pressure of other work having compelled him to resign this, Mr. Arthur Bennett has undertaken the continuation.

Students of the British Flora will turn with great interest to the Supplement; for though our island has been well botanised, new forms are constantly being brought forward, as well as new ideas on the old well-known ones, and a synoptical account of the information every few years is a necessity. Mr. N. E. Brown gives us the result of his evidently careful investigation on the earlier orders, from Ranunculaceæ to Celastraceæ. New forms are fully described, and the localities carefully indicated; the critical points are, moreover, discussed at length, and the author does not hesitate to give his own opinion, though not always in the best of English.

The value of a work like that before us lies, of course, in its practical use, and must be estimated by the practical student, who, though differing in opinion on minor points, can always appreciate and use the facts recorded by a fellow-worker. In one point, however, and that by no means of small importance, we fear Mr. Brown will not obtain universal approbation. We refer to the much-vexed question of Nomenclature. The bewildered botanist has, probably, already learned that the white water-lily is no longer *Nymphæa alba*, but *Castalia speciosa*, while *Nuphar lutea* and *N. pumila* must be put under *Nymphæa*; the genera *Castalia* and *Nymphæa* of Salisbury being three years older than the *Nymphæa* and *Nuphar* introduced by Smith in 1808 or 1809, and used without question for our well-known water-lilies until Messrs. Green and James raked up their proper names in 1887. A service of nearly fourscore years gives no right of way where a name is concerned.

Study of the sublime may, however, lead to the ridiculous, and surely something of the sort has happened here; for turning to page 1 of the additions and corrections we find *Corydalis bulbosa* and *C. claviculata* of De Candolle replaced by *Neckeria bulbosa* and *N. claviculata* of N. E. Brown, while De Candolle's *Corydalis lutea* becomes *Neckeria lutea*, Neck. *Neckeria* (1777) certainly has priority by twelve years, but by Mr. Brown's own showing is also forestalled by two other names, *Capnoides* (1763) and *Split* (1745), the two last being rejected "as names ending in *oides* and others such as *Split* are by common consent considered untenable for generic purposes." This seems rather arbitrary. If common consent availed aught, the water-lilies might have been left undisturbed. Besides, have we not *Castanopsis*,

and why is "oides" worse than "opsis"? Moreover, is *Quamoclit* much worse than *Split?* If the æsthetic sense is to be considered there is no knowing where we shall stop, for tastes differ so widely, and sounds which irritate one author may be as music to another. In the present case, we doubt not soon to see *Split bulbosa*, &c., while if we are first led through *Capnoides*, synonymy will be still further burdened. Much ink and paper were wasted on the rights of *Tissa* and *Buda* not very long ago, but these are now set aside in favour of Mitchell's *Corion* for *Spergularia*. Mr. Brown, has, however, no right to claim these species, for as he in fact points out, the valuable discovery is due to Dr. Britton (*Journal of Botany*, 1891).

The text of the book is good and clear, but the same cannot be said of the plates. Those of *Arabis alpina* and *Polygala amara* are very poor; the former, moreover, is marked 117*a*, but referred to in the text on page 24 as 37*a*. It is a pity not to mention the name of the work on the plates forming part of it, the bare name of a plant and a number giving no clue to its origin should it become detached.

Geography of Africa South of the Zambesi: with Notes on the Industries, Wealth, and Social Progress of the States and Peoples. By Rev. William Parr Gresswell, M.A. 8vo. Pp. 400, with three maps. Oxford: Clarendon Press, 1892. Price 7s. 6d.

This little work is published under the auspices of the Royal Colonial Institute, and though primarily adapted for use in schools and colleges, contains a great deal of information of interest to the general reader. It is prefaced by a brief historical introduction, relating to the gradual progress of the colonisation of South Africa; and there are thirty-two appendices of statistical information and matters interesting to the politician. A good general description of the Physical Features and Natural History of the country is compressed into the space of seventy pages; and the detailed account of the several colonies and territories will prove very useful for reference.

Catalogue of the Type Fossils in the Woodwardian Museum, Cambridge. By Henry Woods, B.A., F.G.S. 8vo. Pp. 180. Cambridge: University Press, 1891 [1892]. Price 7s. 6d.

This is a valuable list of the fossils in the Woodwardian Museum to which reference has been made in published works. It is carefully prepared, beautifully printed, and will be much consulted by Stratigraphical Geologists and Palæontologists. In a brief Preface, Professor Hughes remarks upon the historical interest of the older collections in the Museum, comprising those of Agostino Scilla (1670), Lister (1688), and of John Woodward, the founder.

An elaborate work on the Cuckoo has just appeared in Berlin (*Das Leben der europäischen Kuckucke, nebst Beiträgen zur Lebenskunde der übrigen parasitischen Kuckucke und Stärlinge.* By A. C. Eduard Baldamus. Roy. 8vo. Pp. 224. Pls. viii. Berlin: Paul Parey, 1892.). About 100 pages are devoted to the common European cuckoo (*Cuculus canorus*); and the remainder of the work deals with the other cuckoos and starlings that lay their eggs in the nests of different birds. Eight coloured plates of eggs are given.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

The Committee formed under the presidency of the Marquis of Lorne for the restoration of the Library of the Toronto University have satisfactorily concluded their labours. Having already despatched about 30,000 volumes, they have just forwarded, as a last instalment, four additional cases, containing some 350 volumes of Prussian scientific works, the gift of the German Emperor.

Dr. James D. Dana has retired from the Professorship of Geology in Yale University, which he has held since 1855. He is succeeded by Professor H. S. Williams, whose removal to Yale we noticed last month. Professor Dana is this year the recipient of the Walker Prize of the Boston Society of Natural History.

Professor C. H. Gilbert and his colleagues of the new Leland Stanford Junior University, Palo Alto, California, propose to establish a Marine Biological Station on the Pacific Coast, in the Bay of Monterey. It is hoped to open the laboratory during the coming summer, and facilities will be given for work both by teachers of Natural Science and by specialists engaged in original research.

The Pennsylvanian University in Philadelphia will shortly be extended by the addition of a new Museum of Human and Comparative Anatomy, with fully-equipped laboratories for original research. The museum will contain the Wister and Horner collection, and is the gift of General Wister, who also provides an endowment fund for the curatorship.

The University of Dublin will celebrate its Tercentenary from the 5th to the 8th of July. There will be a commemoration service in St. Patrick's Cathedral, a reception and ball by the Lord Mayor, a banquet in the Leinster Hall, a dramatic performance by graduates and undergraduates at the Gaiety Theatre, and other festivities. The graduates of the University are marking the event by forming a Union, for which a special building will be erected. Delegates have been invited from the Universities and leading colleges of the world. Natural Science will be well represented at the gathering. Professor T. G. Bonney, Dr. J. Burdon Sanderson, Rev. W. H. Dallinger, Mr. Thiselton Dyer, Mr. John Evans, Dr. D. Ferrier, Professor M. Foster, Sir A. Geikie, Professor V. Horsley, Professor J. W. Judd, Professor E. Ray Lankester, Sir J. Lister, Sir J. Lubbock, Professor A. Macalister, Sir L. F. McClintock, Professor H. A. Newton, Baron Nordenksjöld, Sir J. Paget, the Abbé Renard, and Professor H. Reusch are among those who have accepted invitations to be present. Numerous honorary degrees will be conferred, and some of the delegates will be asked to address the students. A movement is on foot to petition the University to signalise its Tercentenary by granting degrees to women.

The fiftieth anniversary of the Doctorate of Professor Albert von Kölliker has just been commemorated by the issue of a special supplement to the fifty-third

volume of Siebold and Kölliker's *Zeitschrift für wissenschaftliche Zoologie*. The supplement consists of ten beautifully illustrated memoirs by pupils and admirers of the Professor. C. Hasse discusses the development of the vertebral column of *Triton taeniatus*, and there are notes by H. Ludwig on an abnormal *Cucumaria planci*, and by W. Voigt on a parasitic copepod found in a *Synapta*. R. Wiedersheim treats of the marsupial bones and epipubic cartilages in vertebrates. G. H. Th. Eimer has an elaborate investigation of the structure of muscle-fibres, while J. Eberth and K. Müller discuss the pancreas. O. Bütschli attempts to show how echinoderms may have been derived from a primitive bilaterally symmetrical form; and there are also contributions from H. Virchow, Th. W. Engelmann, and E. Ehlers.

THE name of M. Hamy is placed first on the list of candidates nominated by the Academy of Sciences for the vacant Professorship of Anthropology at the Paris Museum of Natural History.

IMPORTANT additions are being made to the exhibited collection of Comparative Anatomy in the University Museum, Oxford, and several new cases have been added on the plan of those in the Central Hall of the British Museum (Natural History). Mr. W. P. Pycraft, for some years assistant in the Leicester Town Museum, has recently been appointed to assist in the preparation of the new specimens.

IN a communication supplementary to last month's "Notes," Miss Agnes Crane alludes to the unfortunate circumstance that no facilities are provided at the Brighton Aquarium for biological students to make use of the interesting small organisms that so frequently make their appearance in the tanks. It would not involve much outlay on the part of the directors to develop to some extent the Natural History resources of the institution; and, by taking some steps in this direction, they would merely be carrying out one of the overlooked aims of the original founders. Professor Newton announces that there are vacancies at the Cambridge University tables at the Marine Stations both of Plymouth and Naples.

THE collection of Carboniferous and other fossils made by the late Mr. E. W. Binney, F.R.S., of Manchester, has been presented by his son to the Woodwardian Museum, Cambridge.

SEVERAL societies in London have lately held their Anniversary Meeting. At the *Society of Antiquaries*, on April 23, Mr. A. W. Franks, of the British Museum, was elected President in succession to Dr. John Evans, who has occupied the chair for the customary term of seven years. The *Zoological Society* met on April 29, and re-elected Professor Flower as President. In the Annual Report the Council regret that, for the first time for many years, the total number of Fellows is reduced to less than 3,000. Considering the interest of the collections to the general public and their great importance to the scientific student, we can only feel surprised that the former take so little part in the Society's affairs, and that so many of the latter avail themselves of the advantages offered by the Society while not contributing to its funds. At the Annual Meeting of the *Royal Geographical Society*, on May 23, Sir M. E. Grant Duff was re-elected President. The Founder's Medal was presented to Mr. Alfred Russel Wallace, and the Patron's Medal to Mr. Edward Whymper. On the following day, Mr. Wallace was again the honoured recipient of the Gold Medal of the *Linnean Society*. At this meeting Professor Charles Stewart accepted the Presidency for another year.

THE annual meeting of the Leeds Philosophical and Literary Society was held on May 3. The report referred to the retirement of Professor Miall from the

curatorship of the Society's Museum last October, after a service of 20 years. Mr. Edgar R. Waite has been appointed to the vacant position. Among the more noteworthy additions to the collection of the Museum during the year, are a series of British birds' eggs and a case to illustrate the transformation of insects. Photographs of temporary sections of the Coal-measures in and near Leeds are also a noteworthy acquisition.

Natural Science is well represented in this year's list of selected candidates for the Fellowship of the Royal Society, which includes the names of Frank Evers Beddard, Hans Gadow, Francis Gotch, William Abbot Herdman, Frederick Wollaston Hutton, Louis Compton Miall, Benjamin Neve Peach, and Augustus D. Waller. The remaining names representing Physical Science are those of Robert Young Armstrong, John Ambrose Fleming, Clement Le Neve Foster, John Joly, Joseph Larmor, and Alexander Pedler; while Political Economy is honoured in the person of Mr. Robert Giffen.

By the death of Mr. William Reed, M.R.C.S., F.G.S., of York, at the advanced age of eighty-two years, on May 9, the Yorkshire Philosophical Society has lost its greatest benefactor. Not only did Mr. Reed give to the Museum of that Society his own magnificent general collection of fossils, but with rare liberality he purchased and presented the Whincopp and Baker collections of Crag fossils, the Wood collection of Palæozoic fossils (especially rich in Yorkshire Carboniferous Limestone species), part of the Bean collection (chiefly Jurassic), and the Elwes collection of Tertiary fossils. So far as we remember, Mr. Reed's only paper was a short note on a boring at Masham.

Two parts of the *Transactions of the Hertfordshire Natural History Society and Field Club* (vol. vi., pt. 7, vol. vii., pt. 1) have just been issued, the first occupied by abstracts of proceedings, the second by Mr. Hopkinson's Presidential Address on Francis Bacon. Vol. v. (1891) of the *Essex Naturalist* has also been completed, and the first four numbers of vol. vi. (for 1892) have reached us. This publication is now up to date, and the editor, Mr. William Cole, urges his fellow-members of the Essex Field Club to assist him in issuing the monthly parts punctually and regularly. Last year's volume contains, among others, valuable contributions on the cryptogamic and flowering plants of the county, on certain groups of lepidopterous insects, on the mollusca of the Thames estuary, on the Essex boulder clay, and on the undulations of the Chalk. The new volume opens with an interesting account of the existing flowering plants of Epping Forest as compared with the earlier records, by Mr. J. T. Powell; and Mr. William Cole follows with a discussion of the boundaries of the Forest. Mr. J. French describes evidence of supposed old fish-reservoirs, perhaps dating back to a period anterior to the Roman occupation of Britain. Mr. W. Whitaker contributes statistics of Essex well-sections; and the Rev. Hilderic Friend has a series of notes on British earthworms, with special reference to those of Essex. The *Report of the Marlborough College Natural History Society* for 1891 lately issued contains many small notes of local interest, and there are some observations by Mr. A. S. Eve on "coombs" and "lynchets." Coombs are dry valleys in the Chalk, and lynchets are horizontal ridges or banks on the slopes of the Chalk hills. Mr. Eve thinks that the latter were not made by man.

The May number of the *Quarterly Journal of the Geological Society* (vol. xlviii., pt. 2) contains many noteworthy papers, of which those by Professor Prestwich and Mr. Clement Reid on Pleistocene Britain are noticed elsewhere. In his Presidential Address, Sir Archibald Geikie treats of volcanic action in Britain from the Devonian age onwards. Among the papers the older rocks attract much attention; and there is a valuable memoir by Messrs. Jukes-Browne and Harrison on the Oceanic Deposits of the Barbados. The latter paper, supplemented by a note by Mr. J. W. Gregory,

has an especially important bearing on the question of great recent changes of level in the land of the Caribbean region. In the May number of the *Proceedings of the Geologists' Association* (vol. xii., pt. 7) two great problems are discussed. Professor J. F. Blake treats of the evolution of the Cephalopoda, and alludes to some general principles they seem to illustrate; Mr. H. B. Woodward discusses the subject of life-zones in sedimentary rocks, with special reference to his researches in the Jurassic Formation. The most generally interesting paper in the new issue of the *Transactions of the Manchester Geological Society* (vol. xxi., pts. 16, 17) is Professor Williamson's personal account of his early geological researches (1835 and onwards) in the neighbourhood of Manchester. Another geological paper appears in the last part of the *Mem. Manchester Lit. and Phil. Soc.* (ser. 4, vol. iv.), in which Mr. W. Brockbank attempts to prove the Permian age of the St. Bees Sandstone. There is also a brief valuable contribution to geology in the May number of the *Proceedings of the Royal Geographical Society* (vol. xiv., No. 5), in which Mr. R. M. W. Swan supplements Mr. Theodore Bent's paper on Mashonaland with some geological observations. Central Mashonaland, it appears, consists of elevated granite plateaux, varying from 3,000 to 5,000 feet in height. Groups of isolated little granite hills rise above the plateaux; and the only other rocks represented are quartzite and schists, with some crystalline limestones.

THE Royal Agricultural Society of England has issued eight diagrams illustrating the growth of the Wheat Plant, with explanatory notes by Mr. Carruthers, its consulting botanist. They are published by Messrs. W. & A. K. Johnston, at 10s. the set, and form a most instructive and beautiful series. The diagrams are reproductions of original drawings by Francis Bauer, now in the Botanical Department of the British Museum, and as Mr. Carruthers states, and as all who have seen any of the artist's drawings will fully credit, no more careful study or faithful representations of wheat have ever been made. "The diagrams and notes are prepared for the use of farmers, principally in view of the present interest in technical education, and of the senior scholars in country schools, whose studies are being directed to subjects that will engage their attention through life." The first sheet deals with the structure of the grain, the second with its germination, and the third with the young plant. In the next three the growth and development of the flower and ear are fully illustrated; the seventh shows the ripening of the grain, and the last the structure of the "straw" or stem of the plant. The figures are very clear, and each is carefully described in the notes, where the physiological functions as well as the anatomy of the parts are explained in simple scientific language, while the author has been careful to avoid errors and keep the information up to date.

THE Royal Academy of Sciences and Letters of Denmark offers a prize of 600 kronor for an original treatise on the Natural History of certain marine fishes of the northern European seas. The work should comprise the complete life-history of the fish dealt with, may be written in Danish, Swedish, English, German, French, or Latin, and must be sent in by October, 1894. Further particulars can be obtained from the Secretary, Dr. H. G. Zeuthen, University of Copenhagen.

MR. G. W. LAMPLUGH has been appointed an Assistant-Geologist on the Geological Survey of England and Wales. Mr. Lamplugh is well known through his researches on the Geology of East Yorkshire, and more especially on the Glacial Drifts in the neighbourhood of Bridlington and Flamborough Head, and on the Speeton Clay. He has also studied Glacial phenomena in Vancouver Island. The appointment of so experienced a geologist will add greatly to the strength of the Geological Survey, and we understand that he will carry on the work of mapping in the Isle of Man.

OBSERVATIONS AND CORRESPONDENCE.

The Limpet's Adhesive Power.

Having previously ascertained by a series of experiments, made at Folkestone in the summer of 1889, the force necessary to overcome the great powers of adherence of the limpet, I determined to make another series, in order, if possible, to find out the source of these remarkable adhesive properties.

To do this, I placed several limpets on the side of an empty glass tank; I then drilled two holes through different rings in the top of each shell, and passed through them a stout copper wire. The ends of this wire were twisted together, and then attached to a spring balance. By pulling on the latter, the force necessary to detach the limpet could be readily observed. Owing to the glass plate it was easily ascertained that no air space existed beneath the foot, which in every part was in close contact with the glass.

On exercising slight traction on the limpet, the foot and mantle became still more closely applied to the surface of the glass. There was, therefore, nothing to suggest a sucker-like action.

On injecting the limpet with corrosive sublimate, more than sufficient to immediately destroy all vitality, the shell became quite loose, but still the foot remained adherent. The force necessary to detach the dead limpet was, however, very much less than in the case of the living, for while a force of 35 lbs. was required to remove the living limpet, 25 lbs. sufficed to displace a limpet immediately after poisoning. Twenty-four hours after death a force of 9½ lbs. detached the limpet.

When the limpet was dislodged, a thin gelatinous coat remained on the glass wall; this substance appeared only slightly soluble in sea-water.

We may, perhaps, be justified in concluding from the above experiments that while some portion of the adhesive power may be due to atmospheric pressure, a very considerable amount, if not the major part, is probably dependent upon the throwing out of a very tenacious substance. In favour of the latter view is the definite evidence of the absence of a vacuum beneath the foot, and the fact that the adhesion continues after the death of the animal, also the positive proof of a tenacious secretion.

With regard to the secretion of the limpet, it may be mentioned that many species gradually eat their way into the hard strata to which they may be attached—Limestone, Old Red Sandstone, &c.

J. Lawrence-Hamilton, M.R.C.S.

30 Sussex Square, Brighton.

TO CORRESPONDENTS.

All communications for the EDITOR *to be addressed to the* EDITORIAL OFFICES, 67–69 *Chancery Lane, London, W.C.*

REPRODUCTION OF THE FORAMINIFERA—(*J. Eliot Jenkinson, Edinburgh*).—No very definite information has as yet been obtained on this subject, but important details have been accumulating since 1854, when Max Schultze, in his "Organismus der Polythalamien," figured a *Miliola* and a *Rotalia*, in both of which numerous young shells are shown. Among the Foraminifera it is likely that both fission and gemmation obtain, and there is evidence of viviparous reproduction following segmentation. Strethill Wright has noticed the young in *Spirillina* (*Ann. Mag. Nat. Hist.* [3], vii., 1861, p. 360); Carpenter treated exhaustively of the subject up to his time in his "Introduction," 1862; and Schacko (*Archiv. Naturg.* xlix., 1883, p. 428. and *Sitz. Ges. Nat. Freunde Berlin*, 1882, p. 130) has figured and described *Peneroplis proteus* showing the last fourteen chambers of the shell crowded with embryos, while, to be more exact, he figures another specimen, to prove that the shape of the embryo corresponds precisely with the original chamber of the parent shell. In 1884, Brady ("Challenger" Report) figured a specimen of *Cristellaria crepidula* in which young shells are seen to occupy some of the chambers; and in a more recent paper "On the Reproductive Condition of *Orbitolites complanata*, var. *laciniata*" (*Journ. R. Micros. Soc.*, 1888, p. 693), this condition is beautifully shown. Carpenter had already noticed this in 1862, and Semper, in 1863, had been very near to Brady's discovery (*Zeitschr. Wiss. Zool.*, xiii., 1863, p. 558). (*See also* Schlumberger, *Bull. Soc. Zool. France*, xiii., 1889, p. 222.) As there is no orifice in the three genera last mentioned sufficiently large to allow of the passage of the young to the exterior, it seems highly probable that the birth of the young means the destruction of the parent, unless (which appears to be the case) an actual segmentation of the parent takes place to produce the young. We see the same thing when *Amœba* divides into two; the parent ends independent life and becomes two immature individuals. In *Cymbalopora*, the last or youngest chamber of the mature shell is much inflated, and young shells are found therein; and Brady noticed the presence of the rotaline portion of the mature shell, showing traces of the fractured balloon-shaped chamber in a gathering of mature and young individuals ("Challenger" Report). It is possible, therefore, that in *Cymbalopora* also, the birth of the young means the destruction of the parent. The most recent figure bearing on the subject is that of a *Lagena*, containing a young shell, which is given in a paper by Chaster in the *Ann. Rep. Southport Nat. Hist. Soc.*, referred to on p. 159 of our issue for April.

With regard to the question of sex, De la Harpe, when studying the Nummulites (*Mém. Soc. Pal. Suisse*, vii., 1881, p. 127; *Bull. Soc. Géol. France* [3], ix., 1881, p. 171), observed that there are two recognisable forms of each species, the individuals being divisible by size; and, further, that the smaller shells invariably begin with a large chamber, while the larger shells either have no recognisable central chamber, or one of very small size. Parker and Jones had previously noted the same thing. De la Harpe considered these variations as specific. Munier-Chalmas and Schlumberger took up the question, and came to the conclusion that the difference was one of development only, and that the "pairs" were two forms of the same species (*Bull. Soc. Géol. France* [3], viii., 1880, p. 300; *ibid.*, x., 1882, p. 470; *ibid.*, xiii., 1885, p. 273; *Comptes Rendus*, xcvi., 1883). Schlumberger has found this dimorphism in all the Milioline Group, and all his recent papers (in the publications of the Geological and Zoological Society of France) may be consulted on the subject. De la Harpe, in one of the papers quoted above, suggests that, had it been a fact that sex existed among the Foraminifera, he would have been inclined to regard the size of the central chamber as of a sexual nature, and Patrick Geddes seems to agree with this suggestion (*Proc. Roy. Soc. Edinb.*, 1885–6 [1886], p. 931). The subject has been referred to in many other papers; it is impossible to give a complete list here, but they will all be found in Sherborn's "Bibliography," published in 1888.

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